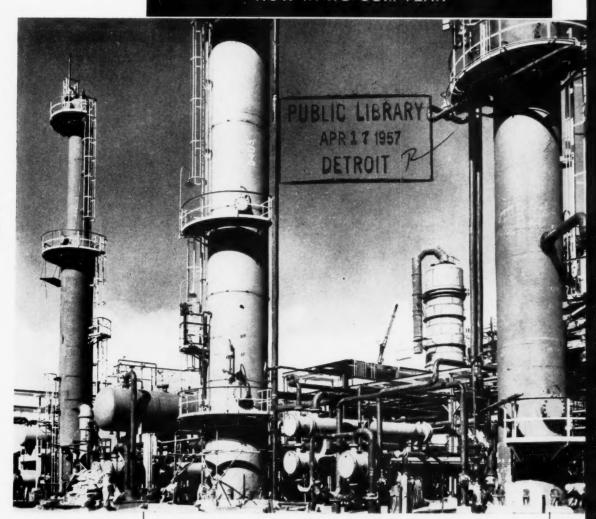
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APRIL, 1957

RUBBER WORLD

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Firestone's Texas Butadiene Plant Completed (page 96)

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By S. M. Cadwell, page 57

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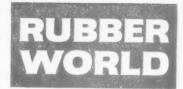
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APRIL, 1957 VOLUME 136, NUMBER 1

FEATURES

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SCIENTIFIC CONTRIBUTIONS TO THE RUBBER INDUSTRY S. M. Cadwell 57

The rubber industry, which has met many technical challenges in the past, is faced with new ones in the petrochemical, polymer chemical and rubber chemical fields.

CURING SYSTEMS FOR IMPROVED AGING RESISTANCE OF RUBBER VULCANIZATES—II Z. T. Ossefort, R. F. Shaw, E. W. Bergstrom 65

Information on aging of sulfur and non-free sulfur compounds in absence of oxygen, and aging of dicumyl peroxide and radiation cured vulcanizates is provided in this concluding instalment.

RUBBER DIVISIONS, ACS AND CIC, MEET IN MONTREAL TO THE TOTAL TO THE TOTAL TOTA

This first joint conference of the American and Canadian rubber technologists includes papers on testing procedures, carbon black, compounding and processing, and new polymers.

AKRON RUBBER GROUP PANEL DISCUSSION ON "PHYSICAL TESTING IN THE RUBBER AND PLASTICS INDUSTRIES"—II

The questions and answers from this panel discussion are covered in this concluding instalment.

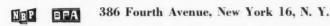
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Compounding is not critical, and ingredients can be modified within fairly flexible limits to obtain physical properties desired for the application. The following recipe is recommended as a basic formulation for high tack compounds:

Hycar 1042 HBS Zinc oxide Sulfur 2.5 FEF Black 40.0 Pyrax A 20.0 Hycar 1312 20.0 KP-555 . . 20.0 MTMT 0.6 **NBS Stearic acid** 209.1

Note: Compound possessed very good tack.

SPECIFICATION COMPOUNDING TO MEET DIFFICULT PRODUCT REQUIREMENTS. Despite the fact that the Hycar nitrile rubber family includes a broad range of types, requests for specialized properties are continually received. This is where our Product Application Laboratory steps in to develop and evaluate specialized compounds. Two recent such developments are of interest:

A low-swell, oil-resisting compound was requested for an accumulator bladder for hydraulic pressure systems. It was essential that tensile strength and elongation would be retained after oven aging, since the bladder is subjected to heat and alternate increase and release of pressure. Two compounds proved satisfactory, one based on Hycar 1042, the other based on Hycar 1002.

A compound that maintained properties upon immersion in fuel was requested for a gasket application. A compound based on Hycar 1041 and 1042 showed a volume swell of only 1%, and no change in hardness, after immersion for 60 days in Reference Fuel B, followed by 30 days drying.

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Another use where the liquid polymer can prove valuable is in substituting for part of the Hycar in recipes to improve processing characteristics, in compounds where high hardness is desired in the cured state.

For further information on Hycar nitrile rubber, write Dept. HN-4, B.F. Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ont.



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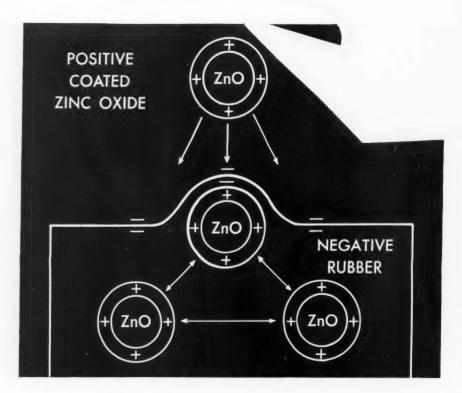
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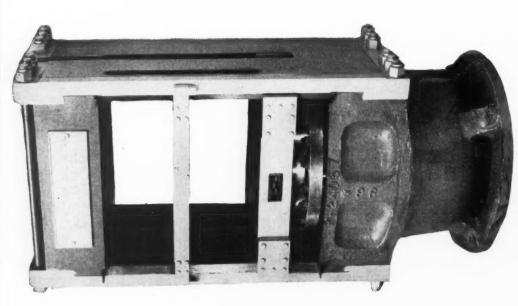
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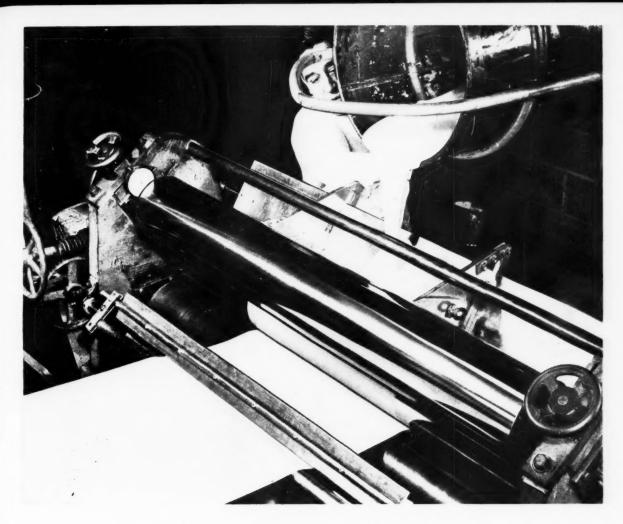
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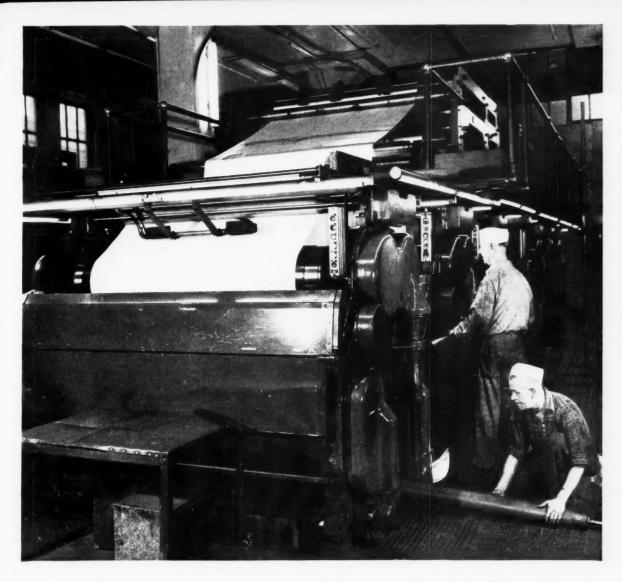


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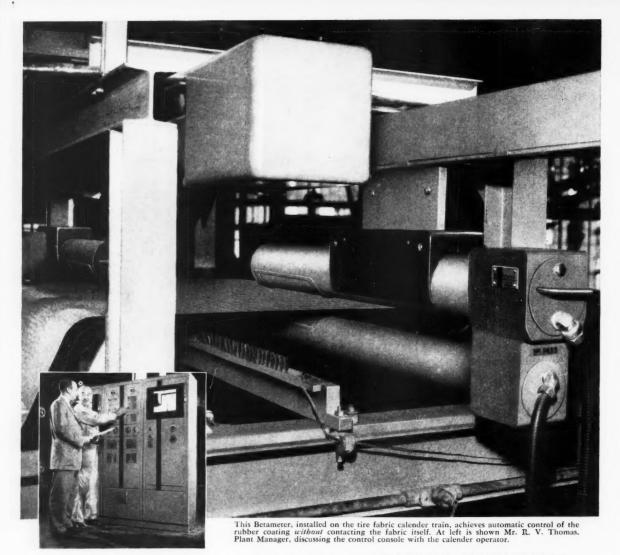
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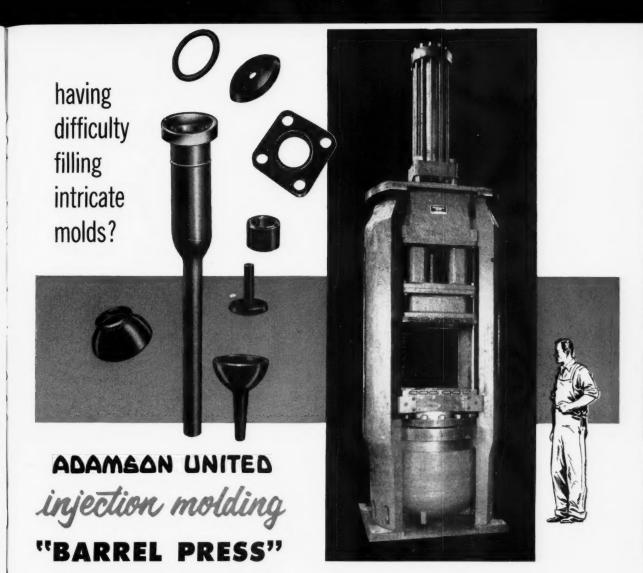
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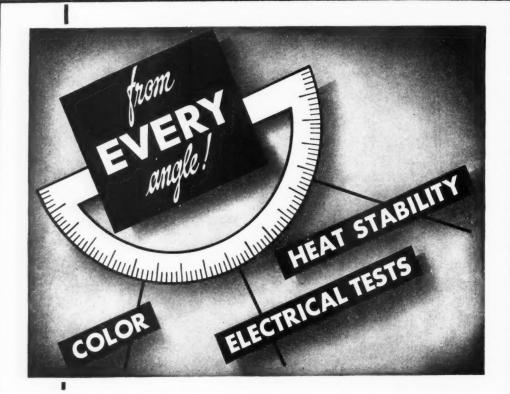
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BAYTOWN MASTERBATCHES, manufactured at Baytown, Texas, by *United Rubber & Chemical Company*, offer many advantages to the fabricator.

Here are a few examples -

BAYTOWN MASTERBATCHES are clean. They come to the user uncontaminated.

They're uniform. Specification limits are carefully controlled and maintained.

They're free from undispersed dry carbon black and have exceptionally low marking properties when handled.

And they have proved their utility and reliability—and their constantly improving quality—in factories both here and abroad.

Let our technically trained sales representatives (our sales offices are listed below) tell you how BAYTOWN MASTERBATCHES are being used so widely in tread stocks and other tire applications. Let them outline for you the way these masterbatches have established their excellence for the production of high quality mechanical goods and other molded products.

BAYTOWN MASTERBATCHES . . . the name is a symbol of quality!

-UNITED CARBON COMPANY, INC.

A subsidiary of United Carbon Company

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AKRON LOS ANGELES CHICAGO

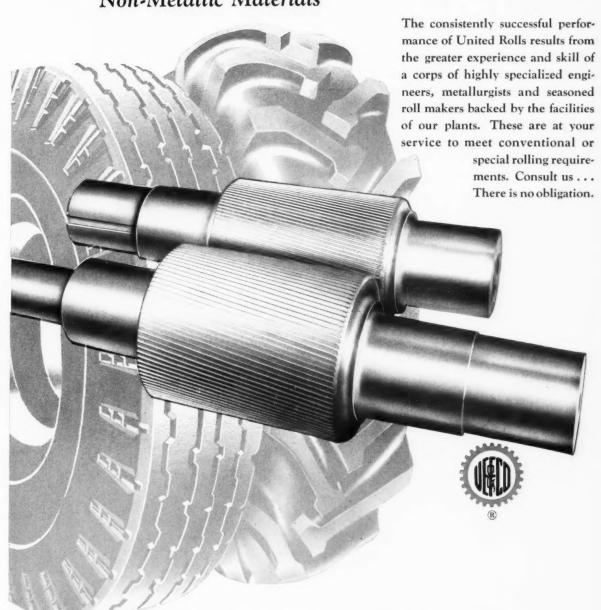
IN CANADA: CANADIAN INDUSTRIES LIMITED

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Plastics...Tile...Paint...Linoleum and other Non-Metallic Materials



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SUBSIDIARIES: Adamson United Company, Akron, Ohio
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Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

"sponginess"



under valve base

SOLUTION ... KURE-BLEND MT

This very problem faced a leading tire tube producer six months ago. The problem was completely solved by adding Kure-Blend MT during stock processing. Several others have proved the same benefits since. This curing problem could have been solved by increasing cure time ½—1 minute, but Kure-Blend solved it without any increase in time.

Kure-Blend®, a 50 GRS-50 TMTD latex-compounded masterbatch, provides faster, more even dispersion, thus allowing full advantage to be gained from TMTD used for acceleration.

Kure-Blend offers these additional advantages:

- Faster, easier incorporation
- Can be more accurately weighed
- Indefinitely storage-stable
- No dusting
- Assures uniform cure
- No premium cost

There's no need to increase cure time—just add Kure-Blend MT to be sure of tube cure!

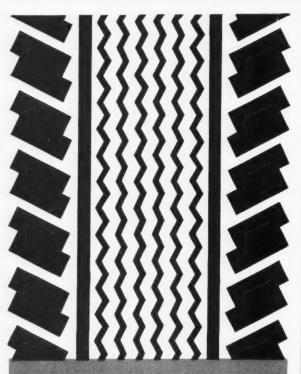
For literature and samples, write to:

THE GENERAL TIRE & RUBBER COMPANY

Chemical Division AKRON, OHIO

Creating Progress Through Chemistry





"Bag-O-Matic" presses are enjoying increased popularity in the tire industry. But, the high operating temperature of these presses puts severe demands on rubber lubricants. Lubricants must perform efficiently under these new conditions. That's why you should consider Ucon rubber lubricants in "Bag-O-Matic" presses.

UCON Rubber Lubricants . . .

- insure proper forming of the tiregive clean release
- increase bladder life

The low volatility of Ucon rubber lubricants prevents sticking. So, the quality of the finished tire is improved. Production loss due to cleaning operations is also reduced because Ucon rubber lubricants retard the formation of gummy deposits on equipment. And, Ucon rubber lubricants are available in both water-alcohol soluble and gasoline soluble series.

Ucon rubber lubricants can help you make a better tire. Write for samples and further information.

CARBIDE AND CARBON CHEMICALS COMPANY

A Division of Union Carbide and Carbon Corporation 30 East 42nd Street III New York 17, New York

"Ucon" is a registered trade-mark of Union Carbide





The Institution of the Rubber Industry

LONDON

The I.R.I., which was founded in 1921, is now a great association of people engaged in all branches of the Rubber Industry. Its members include rubber producers, manufacturers, scientists, technologists, executives, students and others, in many countries of the world.

It has reached its present position of authority and respect through the high standard it has set for the technical literature it publishes, the diplomas it awards, and the meetings and conferences it organizes.

In collaboration with other Societies, it aims to raise the standing of the Industry throughout the world by improving the technical qualifications of its personnel, extending the study of its raw materials, processes, and products, and by promoting the exchange of technical discovery and information by means of literature, conferences, and meetings.

Membership of the Institution is open to all interested at an annual subscription of \$7.50 which entitles the member to receive the bimonthly Transactions free of charge and to purchase other publications (such as the Annual Reports and Monographs) at reduced rates. It also serves to put him in touch with his colleagues and their work in other parts of the world and confers on him full rights to vote, to nomination for election to the Council and to participate in meetings and Conferences organized by the Institution.

> Complete details are easily obtained by writing to:

SECRETARY

INSTITUTION OF THE RUBBER INDUSTRY 4. KENSINGTON PALACE GARDENS LONDON, W. 8, ENGLAND

Naugatuck PYRATEX



gives super adhesion to carcass cords!

Planes, off-the-road trucks and earth-moving equipment put terrific strains on tire carcasses...strains that demand *super adhesion* in the rubber that bonds the carcass cords. And that's the kind of adhesion PYRATEX* gives to rayon, nylon or cotton cerds!

This vinyl pyridine copolymer latex, compounded with resorcinal-formaldehyde, can be used full strength as a cord or fabric dip to produce maximum rubber-to-fiber adhesion. For lower-cost formulations the Pyratex-resorcinal-formaldehyde compound may be added to a butadiene-styrene latex in the proportion of 25 to 75 on the basis of solids content. For use as a cord dip the solution is further diluted to a solids concentration of between 10% and 20%.

Even this economical blend of PYRATEX gives RS-type latex almost two-thirds more adhesion to rayon and nylon fibers. . greatly improves fatigue resistance.

Take advantage of the *super adhesion* of PYRATEX to give greater carcass strength and longer life to *your* tires, hose, belting and other fabric-reinforced rubber goods!

Order a trial drum or truckload today...or contact your nearest Naugatuck branch office for further data.



Naugatuck Chemical

Division of United States Rubber Company Naugatuck, Connecticut

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*Naugatuck's trade name for its vinyl pyridine latex.

Solvent-Resistant Paint Spray Hose Based on "THIOKOL" Synthetic Rubber



ORDINARY RUBBER-COMPOSITION LINER after laboratory tests for solvent resistance shows deterioration caused by action of common paint thinners.



"THIOKOL" SYNTHETIC RUBBER-COMPOUNDED LINER, manufactured by DeVilbiss Co., Toledo, Ohio, shows no deterioration after being subjected to identical solvent action.

PROTECTS AGAINST SWELLING, PLUGGING, PAINT DISCOLORATION AND CONTAMINATION

Hose linings compounded with "Thiokol" Synthetic Rubber Type FA display outstanding resistance to the deteriorating effects of lacquer, paint thinners, aromatic fuels and a wide range of other solvents.

"Thiokol" synthetic rubbers are tough and resilient polymers. When compounded and vulcanized, they display exceptional resistance to most aliphatic and aromatic solvents. They are highly impermeable to gases, moisture and liquids.

"Thiokol" synthetic rubbers are unaffected by aging, weathering, ozone and sunlight, and have a service temperature range of $-60^{\circ} F$ to $+250^{\circ} F$. They can easily be fabricated into many shapes by extruding, molding and calendering, and may be compounded into permanent, non-volatile putties.

For additional information and samples, write: THIOKOL CHEMICAL CORPORATION, 784 NORTH CLINTON AVE., TRENTON 7, N. J. In Canada: Naugatuck Chemicals Division, Dominion Rubber Company, Elmira, Ontario.

"Thiokol" Synthetic Rubbers Provide:

- · resistance to solvents and oils
- · low temperature flexibility
- resistance to sunlight, ozone and aging
- impermeability to gases, moisture and liquids



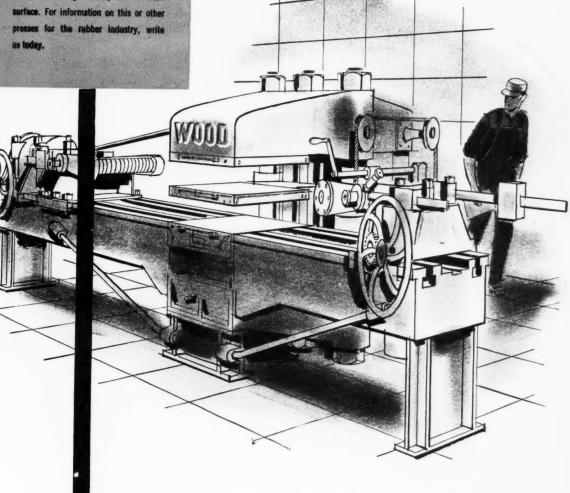
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Open Gap 47-Ton Belt Press for curing flat and V-type transmission belts. The moving platen is accurately machined from a rolled steel stab and is guided by long, full-round babbitted guides on the strain rods. Intermediate platen has drilled channels to provide two heating circuits, one for each surface. For information on this or other presses for the rubber industry, write us today.

Prelude to low-cost production

When an R. D. Wood Press swings into action, gratifying things happen to production costs. For, in most cases, production climbs to a new high and downtime for repairs approaches zero. The reason is the smooth, dependable performance of R. D. Wood Presses—even under difficult conditions. And the reasons for this superior performance are the exacting standards set by R. D. Wood—in design, selection of materials, and craftsmanship. If your company's theme is low-cost production, here is your prelude—ready made.

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act as a thickener when stability of viscosity
/ is important

provide greater dilutability

aid film formation

improve spreading characteristics

impart body and workability to films

These water-soluble polyacrylates are available in the correct pH, solids content, and viscosity for your requirements.

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Does debate settle a hot problem?

(Dow salesmen let Vulcosal speak for itself)

Some problems can be solved by airing the pros and cons. But in the final analysis, don't we all say, "Let's see the proof"?

Is Vulcosal* truly a dustless industrial salicylic acid? Does this retarder solve scorching problems best?

Numerous manufacturers of rubber products have found the answers to be definitely "yes" and are benefiting accordingly. They made firsthand examinations of Vulcosal; for neither description nor debate can resolve a problem that involves a switch in process . . . that puts money at stake. Results rule. $\,$

So our salesmen let Vulcosal speak for itself—not as a last resort, but as a spearhead. For testing Vulcosal results in buying Vulcosal! Test a sample yourself!

See how it ends scorching problems and, at the same time, improves working conditions through its lack of dust. The DOW CHEMICAL COMPANY, Midland, Mich.. Dept.FC859M-1.
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will keep this uncured rubber from

when slabbed or stacked in storage

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A microscopic film of

GLYCERIZED LUBRICANT

You won't be able to see it on the rubber but you will know of its presence because of the non-adhesive properties it imparts. Does not interfere with tack or knit of stock.

ASK FOR SAMPLE!

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SYNTHOL

MICROFLAKE

Goodrich-Gulf Chemicals, Inc.



NEW DEVELOPMENT:

Goodrich-Gulf introduces Ameripol "crumb rubber" to save you processing equipment and cost

ALL Ameripol hot polymers are now available in the form of crumb rubber — developed and introduced by Goodrich-Gulf Chemicals.

This innovation in butadiene-styrene rubber is of particular value to manufacturers of rubber adhesives, mastics, cements, or other products where the rubber raw material must be put in solution before processing. Here the need for milling or chopping equipment and operations is eliminated, and the Ameripol crumb rubber can be processed as received.

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Ameripol hot polymers in crumb form have been fully evaluated in use, and are now available in production quantities. More than ever, Ameripol is the preferred man-made rubber. Contact us for your requirements.

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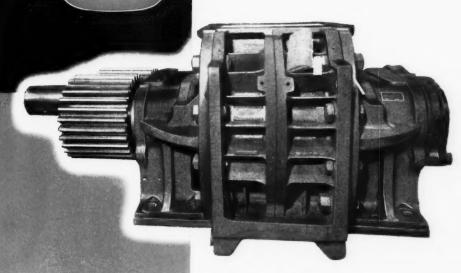
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You can trust TITANOX white pigments with any brightening, whitening or opacifying job in plastics. For the thinnest vinyl sheet or the plumpest children's doll, you can choose the exact pigment for highest opacity, clarity of color, delicate toning or a given brightness.

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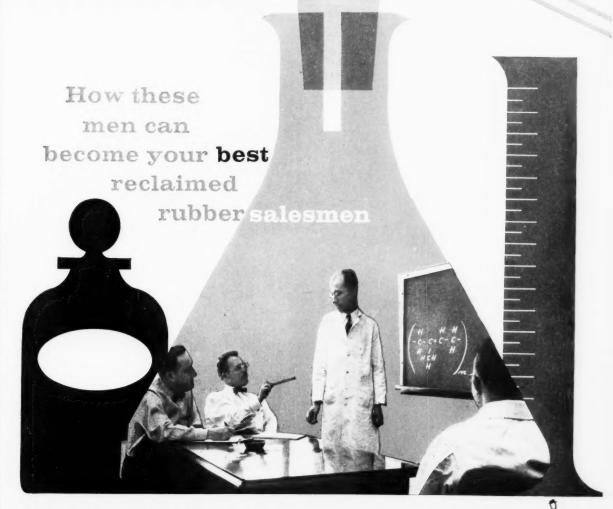
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*TITANOX is a registered trademark for the full line of titanium pigments offered by Titanium Pigment Corporation.

RUBBER WORLD



Velsicol chemists, working with information furnished by your Velsicol representative, can develop custom reclaiming oils that will make your reclaimed rubber easier to process and easier to combine with natural and synthetic rubber.

By supplying an oil that meets your exact requirements, they can increase your sales to new and existing markets, and greatly improve your competitive position. Contact your Velsicol representative now, and put Velsicol research to work in your reclaiming processes. No cost or obligation. Mail the coupon today for new technical literature!



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Adhesive Coatings, Resin Emulsions, Hot Melt Adhesives, Binders, Sizes and Saturants.

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The Complete Line that meets tomorrow's production today!

Bolling builds 4 production sizes for a range of capacities: No. 3 (3400 cu. in.), No. 4 (5100 cu. in.), No. 10 (12160 cu. in.), No. 12 (16000 cu. in.). Also one production-laboratory model—No. 1B (1200 cu. in.). Also one laboratory model—No. 0 (275 cu. in.).

In Bolling mixers, laboratory or production size, you get:

Spiral-Flow Sides for the heating or cooling of

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Write on your letterhead for Mixer Bulletin

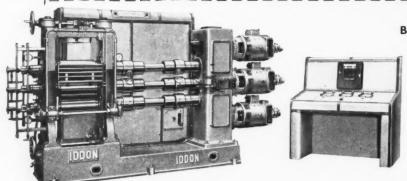


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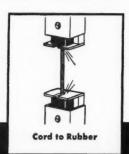
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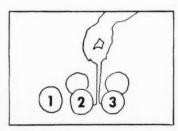
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Non-staining extending oil

For light-colored rubber



Iron Pyrophosphate Recipe

1. GRS-1707
2. Base Polymer (top) and Dutrex Oil Masterbatch (37.5 phr.)

Sulfoxylate Recipe

3. Base Polymer (top) and Dutrex Oil Masterbatch (37.5 phr)

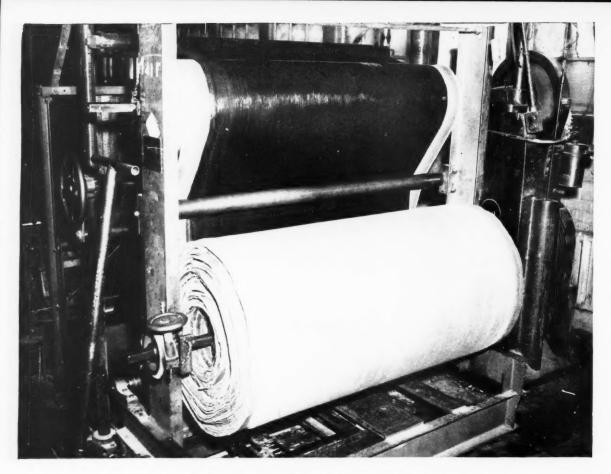
Shell Dutrex 33 is an entirely new lightcolored, compatible naphthenic extender for butadiene-styrene rubber. The outstanding non-staining, non-discoloring properties of Dutrex 33 are retained in oil masterbatch vulcanizates even after severe sunlight exposure.

Dutrex 33*provides superior light color in oil masterbatch based on conventional iron pyrophosphate recipes, but its maxi-

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For further information write or call Shell Oil Company, 50 West 50th St., New York 20, N. Y., or 100 Bush St., San Francisco 6, California.

SHELL DUTREX 33



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Eliminate Adhesions at the Bias Cutter

If your stock has been stored in a Climco Processed Liner, you can depend on easier, faster production, and the stock always separates from the liner cleanly, easily.

And Climco Processed Liners preserve the tackiness of the stock; exclude mould, bloom and sunlight. Rejects and losses due to gauge distortion are sharply reduced.

To speed production and to lengthen liner life, Climco Processing has been

accepted in the rubber industry for 31 years. For superior liners, try Climco Processed Liners.

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Illustrated booklet tells about Climco Liners and Linerette separating paper. Tells how to get better service from liners. Write for your copy now.

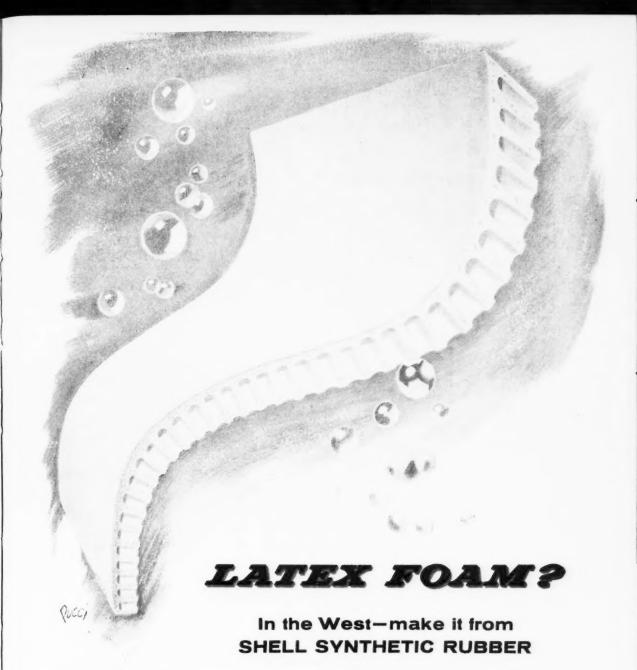




CLIMCO PROCESSED LINERS

FOR FASTER, BETTER PRODUCTION AT LOWER COST







If you make or contemplate making foam rubber products, you will be glad to know that a new unit to produce cold high solids butadiene-styrene latices has just come on stream at Torrance.

Shell Chemical's newest Latex S-2105 has excellent uniformity, color and aging properties. It is ideal for latex foam, carpet backing adhesives and other applications where a high-solids latex is required.

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Convenient location and diversity of product make Torrance your logical Western source for synthetic rubber. Important, too— Shell's Technical Service Laboratory is ready to help you find practical solutions for troublesome technical problems.

Think of Torrance, California, whenever you need synthetic rubber in solid types or liquid latices. Our phone number in Los Angeles is Faculty 1-2340.

SHELL CHEMICAL CORPORATION

Synthetic Rubber Sales Division P. O. Box 216, Torrance, California

Manufacturers of CANARY LINERS

Mildew-proofing and Flame-proofing Cotton Fabrics as per Government Specifications. Write or Wire for Samples and Quotations.

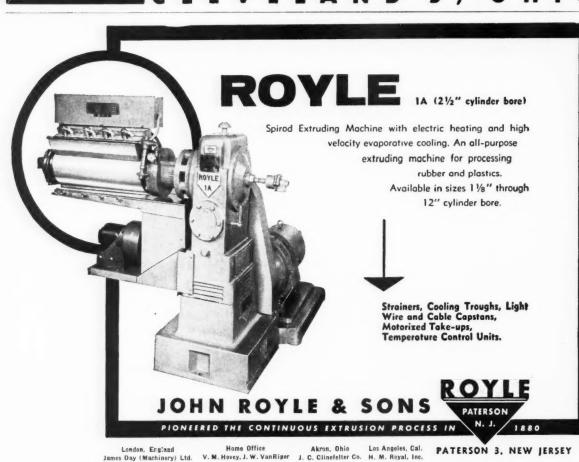
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TILTING HEAD PRESS

Molds Stay Put — Operator Removes Work



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Foot Pedal



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Valve Stem



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The Tilting Head removes the strain of shifting, lifting and horsing heavy molds. Molds fasten to platen. Jaws open—operator removes work. Molds are filled—press closes. High unit platen pressure.

Above you see a few examples of articles now produced on Tilting Head Presses in use. You can adapt the Tilting Head for shallow, deep or transfer molding.

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PLANTS IN WARREN, OHIO - ELLWOOD CITY, PA.

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EEMCO heavy duty hydraulic presses for compression or transfer molding, laminating and polishing, and reinforced plastics molding are furnished with or without self-contained pumping units and special modifications. They are manufactured in all sizes from small laboratory presses to the largest sizes to suit any requirement.

Investigate EEMCO's complete line of Hydraulic Presses. Our engineers will gladly assist in solving any "Press Problems" you may have. Call or write today.

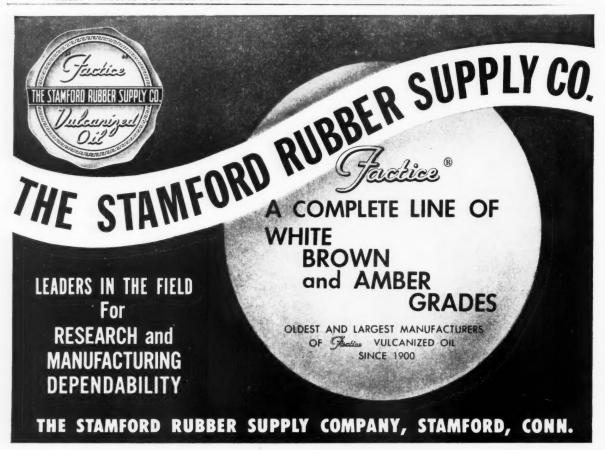




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The Heart and Soul of tough-wearing, color-fast products

FOR RUBBER PRODUCTS NEEDING THESE PROPERTIES

- Bright and permanent non-staining colors
- Extreme resistance to wear, weather and moisture
- Controlled "blow" in chemically blown stocks
- Exceptional dimensional stability

Use Synpol 1502

The butadiene-styrene copolymer 1502 has a long-standing reputation for excellence in the sole and heel, and tire industries.

Now with improvements made by TEXUS (Texas-U.S. Chemical Company) which include the use of a new non-staining stabilizer, SYNPOL 1502 may be used for products requiring bright, stable colors. In the making of white or brightly colored food conveyor belts, floor tiles, mats, electrical jacket stock, tires or lightweight chemically blown shoe soles the properties of SYNPOL 1502 are particularly applicable.

If you plan to produce a new product or improve your present line, write for processing data and compound formulations from your TEXUS technical sales representative.

Carload Pooled Shipments

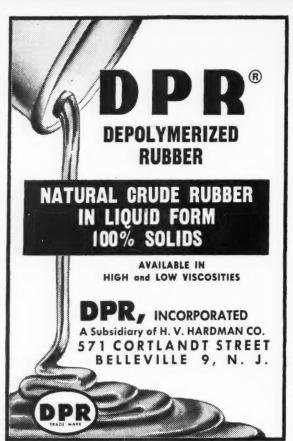
Take advantage of carload discounts by pooling all your requirements from SYNPOL grades and types—the broadest available line of butadienestyrene type rubbers which includes: 1000, 1001, 1002, 1006, 1007, 1009, 1012, 1013, 1061, 1500, 1502, 1551, 1703, 1707, 1708 and 1711.

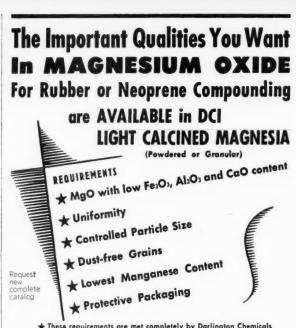


Sales Agent Naugatuck Chemical Naugatuck, Conn. Plants Texas-U. S. Chemical Co. Port Neches, Texas

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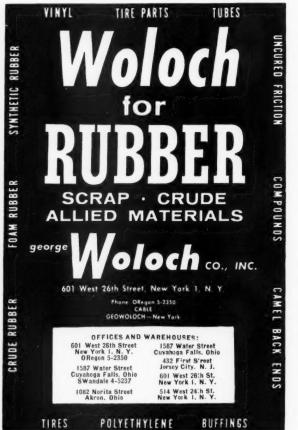
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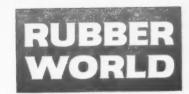
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EDITORIAL

APRIL. 1957

New Elastomer Nomenclature Warrants Industry Acceptance

THE need of a new and complete classification system for the basic raw materials (polymers) used by the rubber industry has been at least partially satisfied with the acceptance and publication by the American Society for Testing Materials of the "Tentative Recommended Practice for Nomenclature for Synthetic Elastomers and Latices—ASTM D 1418-56T." This nomenclature appears in the 1956 "Supplement to Book of ASTM Standards Including Tentatives-Part 6, Plastics, Electrical Insulation, Rubber, Electronic Materials." The further need now is for industry, government, and the technologists to understand and use this nomenclature to reduce the growing confusion in terminology.

As explained in ASTM D 1418-56T, reprints of which are available from the Society, "the purpose of this recommended practice is to provide a standardization of terms for use in industry, commerce and government and is not intended to conflict, but rather to act as a supplement to existing trade names and trade marks. In the case of the term Government Rubber Styrene, abbreviated GR-S, it is intended to replace this term and abbreviation since it is no longer applicable after the production facilities were sold to private industry."

In this new nomenclature, the term "Government Rubber Styrene" and the abbreviation "GR-S" are replaced by "styrene-butadiene rubber" and "SBR". RUBBER WORLD first began using this term and abbreviation in May, 1956, and has been using them ever since. The subcommittee on synthetic elastomers of ASTM Committee D-11 on Rubber and Rubber-Like Materials, which developed this new nomenclature, has recommended its use in all ASTM publications and by government agencies con-

cerned with rubber. RUBBER WORLD urges strongly its prompt adoption by the rubber and associated industries.

It is desirable that generic terms and abbreviations other than the ones for styrene-butadiene rubber (SBR) become better known and used also.

Generic terms and abreviations for the "R" family of elastomers, which are defined as those having an unsaturated carbon chain, for example, natural rubber and synthetic rubbers derived at least partly from diolefins, should be of particular interest. Some of these are as follows: butadiene rubbers, BR; chloroprene rubbers, CR; isoprene rubbers, synthetic, IR; isoprene rubbers, natural, NR; isoprene-isobutylene rubbers, IIR; nitrile-butadiene rubbers, NBR; and pyridine-butadiene rubbers, PRR.

Although the numerous rubbers in the R family have been defined with a considerable degree of completeness, other important families of elastomers, for example, the "M" family and the "U" family, will need definition as soon as possible. The M family comprises elastomers having a saturated carbon chain of the polyethylene type, e.g., acrylate, fluorocarbon, polyethylene, and polyvinyl chloride elastomers. The U family includes elastomers having carbon, oxygen, and nitrogen in the polymer chain, e.g., polyure-thanes.

RUBBER WORLD urges the technical men of the rubber and associated industries to examine and aid in the full development of this new nomenclature. It will be to their advantage.

R. G. Seaman

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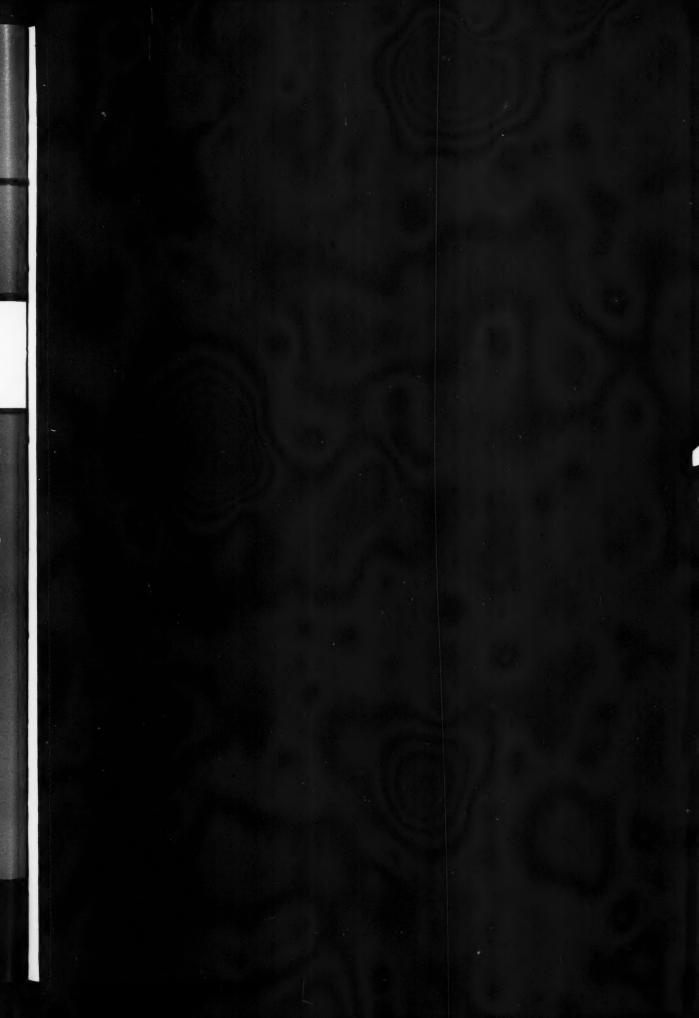
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Scientific Contributions to the Rubber Industry¹

By S. M. CADWELL

United States Rubber Co., New York, N. Y.

Among the scientific contributions to the rubber industry mentioned are the development of natural rubber plantations, accelerators, antioxidants, carbon black, tire cord of synthetic fibers, synthetic rubbers, and plastics.

The acquisition of the styrene-butadiene rubber producing facilities from the government has increased the activities of the rubber industry in the dustry to match the research spending of the chemical industry is considered an obvious necessity. The plea for formation of a cooperative rubber research institute to do long-term fundamental re-

petrochemical, polymer chemical, and rubber chem-

Increased research spending by the rubber in-

search is renewed.

ical business.

I GREATLY appreciate the honor of receiving the Charles Goodyear Medal of the Division of Rubber chemistry of the American Chemical Society for 1956. I appreciate it for myself and for my many colleagues in the United States Rubber Co. who have helped make the contributions for which I am receiving the medal.

The Rubber Division has become a large and very important division, and any honor conferred by this Division is indeed appreciated. In part, the rubber industry has come to occupy the place that it has because of the quality of the technical contributions that it has made. The technical men of the rubber industry have made technical contributions not only to the rubber industry, but to many other related industries, and to American industry and life. The birth of the rubber industry, as we know it, was made possible by a technical contribution. The discovery of vulcanization by Charles Goodyear was one of the great technical contributions of the Nineteenth Century. It gave us our great industry.

I feel greatly honored to be the recipient of a medal named in his honor.

The growth and activity of the Division of Rubber Chemistry, ACS, is strong evidence of the importance of scientific contributions to the growth of our industry. In the matter of membership alone the record of the Rubber Division is outstanding. In the last 17 years the membership of our Division has grown more than five-fold. Further evidence of the active interest our industry

has taken in the scientific side of its business is given by the record of attendance at the Rubber Division meetings since 1919.

It is estimated that the total attendance at the Rubber Division meetings since the first meetings is something over 32,000. Our Division has grown not only in members, but in importance. A review of the scientific papers being presented at this fall meeting will give you some idea of the wide range of scientific interests covered by this Division.

I recall with a great deal of personal pleasure the early discussions that led to the founding of the journal, Rubber Chemistry and Technology, and it is gratifying to see the place it has come to occupy in the field of technical literature. The American Chemical Society monograph on the "Chemistry and Technology of Rubber" (1)² and "Synthetic Rubber" (2) by G. S. Whitby, prepared under the auspices of the Rubber Division, were other milestones in the development of the scientific side of our industry.

Rubber science, as we know it today, has progressed to the point where it covers almost the whole spectrum of scientific activity. R. P. Dinsmore in his Goodyear Medal Address last year, entitled "Specifications for a

¹ Charles Goodyear Medal Address. Presented before the Division of Rubber Chemistry, ACS, Atlantic City, N. J., Sept. 20, 1956

^{1956.}Numbers in parenthesis refer to Bibliography items at end of this article.



Fig. 1. View of a modern rubber plantation of United States Rubber Co. in Malaya

Rubber Chemist." (3) put in a very graphic and interesting manner the wide range of scientific interests that are covered by the rubber chemist and suggested that the complete rubber chemist, who he referred to as Dr. Elastomer, would have to be acquainted with almost every field of modern science, and his acquaintance would have to be more than superficial.

Rubber Industry Dimensions

The broad range of the technical side of the rubber industry is indicated in part by the standing of the rubber industry as a purchaser of products from chemical and allied industries. Last year the Stanford Research Institute made a study of the purchases by all industries from the chemical and allied products industry in 1947 (4). The rubber industry was rated among the top six of 36 industries. That year the rubber products industry bought more than \$630 million worth of chemical products. In 1955 the tire industry consumed directly or indirectly 4.224,000,000 pounds of chemicals (5); so it can be recognized that our industry continues to be a good customer of the chemical industry.

One may also measure the importance of technical contributions to an industry by the rate of growth of that industry. According to figures submitted by the Stanford Research Institute (6), the rubber industry between the period of 1930 and 1955 had a growth rate of more than 5% per year, and only to be surpassed in this growth rate by (1) industrial chemicals; (2) transportation equipment, which includes automobiles; (3) machinery; and (4) non-ferrous metals. I wonder how many of you know of any other industry more than 100 years old which is able to show such a growth rate.

Technical Challenges

Over the years the rubber industry has been under a lot of pressure and has been confronted with many technical challenges. It has grown because it has been able to step up to its technical challenges and has been able to make use of the latest and most erudite scientific

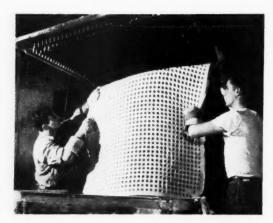


Fig. 2. Foam rubber mattress being removed from mold in a U. S. Rubber plant

work to help it do so.

The introduction of the modern automobile put pressure on our industry and presented it with many of its technical challenges. You remember the automobile and truck and fast farm vehicle and military vehicle would be impossible without rubber tires to smooth out the ride sufficiently. This was particularly true as the air pressure in the tires was reduced. So it is evident that the demand for tires rose as these transportation vehicles found greater and greater favor.

Also, rubber was the first commercial, available thermosetting plastic. Unvulcanized rubber stocks were tacky enough to permit assembly by adhesion.

Many other properties of rubber exerted pressure for the growth of the rubber industry, but a whole series of scientific and technical challenges had to be met to permit the marvelous growth that has actually occurred.

I am going to discuss in order the challenges that were met and show how they have drawn our industry further and further into broad fields of science and chemical production.

The availability of many plastics and synthetic rubbers has led to recent revolutionary changes in our use of raw materials. Our recent acquisition of the styrene-butadiene rubber (SBR) (7) producing facilities from the government has, overnight, made us a major factor in a highly complicated and important phase of the chemical business. I shall seek to discuss what these changes mean to our industry and where they may lead us.

One of the first challenges faced by the growing rubber industry was the need of a suitable source of supply of its basic raw material.

Plantation Rubber

The original raw rubbers were wild rubbers. They were so non-uniform and dirty that they could not suffice as the basic raw material for the kind of expansion the rubber industry was undergoing in the early 1900's. Our industry met that challenge by developing the plantation industry in the Far East (see Figure 1) and attacking and solving the many problems involved in raising the yield from 300 pounds an acre per year

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The Author

S. M. Cadwell, director of research and development, United States Rubber Co., received his bachelor of science and doctor of philosophy degrees from the University of Chicago in 1914 and 1917, respectively. He joined U. S. Rubber as a research chemist in 1919, after having served as a captain in the U. S. Army Chemical Warfare Service during World War I.

Dr. Cadwell was made assistant director of the rubber company's general research and development laboratories in 1930 and soon after became director of tire development for the company, with headquarters in Detroit, Mich. In 1945 he was appointed assistant general manager of the tire division, and in June, 1946, he was named to his present position, with headquarters in New York.

Dr. Cadwell was cited for his "pioneering research in the field of rubber accelerators and antioxidants," in connection with his selection as the recipient of the Charles Goodyear Medal of the Division of Rubber

Chemistry of the American Chemical Society for 1956. He has contributed much to scientific advancement in rubber and during and since World War II did notable work in the development of synthetic rubbers and their use in the rubber industry.

He is a member of numerous scientific and professional societies including the ACS, the



Pach Bros.

S. M. Cadwell

American Association for the Advancement of Science, the American Institute of Chemical Engineers, the American Physical Society, Society for the Chemical Industry, Sigma Xi, etc. He is also a Fellow of the Chemical Society of London and a past chairman of the Division of Rubber Chemistry of the American Chemical Society.

to 2,000 pounds an acre per year. Members of the rubber industry are among the largest farmers in the world, and the progress that they have made in yield is comparable to the progress made in any other agricultural industry.

We not only got a supply of uniform rubber at a very much lower price, but also a supply of natural latex became available on the plantations.

Natural Rubber Latex

We met another challenge when we learned how to preserve natural rubber latex and import it half way around the world without coagulation. A beautiful new products job was done with latex by finding many, many diverse uses for it.

The first application, and one of the most important, was in the treatment of tire cord. This was adopted by the whole tire industry and is still used.

W. A. Gibbons (8) of our company, pioneered in the application of latex in the production of the widely used extruded latex thread—known as "Lactron" and contributed very greatly to advances in the field of latex technology.

The most spectacular application of natural latex was for foam sponge: today this is one of the fastest growing businesses in the country. (See Figure 2.)

Accelerators

The need of reducing the time of vulcanization and thereby reducing the equipment required for vulcaniza-

tion was another challenge presented to our industry. Organic accelerators were developed which could reduce the time any desired amount and could even cause vulcanization to go on at ordinary room temperatures. With many of the accelerators, vulcanization was so rapid that it would go on during the milling of the stock and cause it to scorch. This scorching was minimized by the use of chemical derivatives of the accelerator, such as disulfides, monosulfides, and various kinds of esters, by the use of acid retarders, and most recently by the use of the sulfenamide accelerators.

Another scheme was to divide the accelerator into two parts and introduce part of it by milling and the rest by diffusion.

Reduction of vulcanization time and reduction of the amount of equipment required was adequately accomplished by the use of accelerators, but an even more important contribution was the improvement in aging of the stock; this was permitted by the use of powerful organic accelerators. Years ago we used eight or ten parts of sulfur on 100 of rubber in order to get vulcanization in three hours or so. It was next to impossible to stop the cure when the optimum amount of sulfur was combined, and over-vulcanization caused bad aging. Besides, over-vulcanization occurred during storage and use and also caused bad aging.

It was found that the bad aging was due to two factors: First, if too much sulfur became combined, it gave a poor stock. Second, the more sulfur that was combined the more rapid was the attack of oxygen on the stock,

³ United States Rubber Co. trade mark.

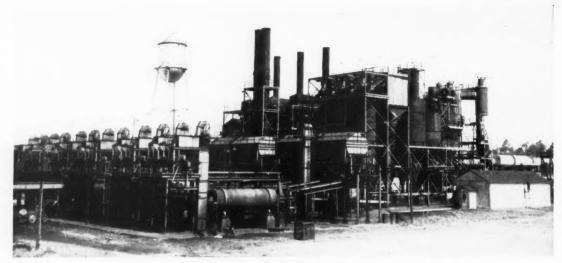


Fig. 3. Furnace carbon black plant of Columbian Carbon Co. at El Dorado, Ark.

and therefore the more rapid was the oxidation deterioration.

Accelerators permitted adequately rapid vulcanization with the use of three or less parts of sulfur per 100 of rubber. This practically eliminated over-vulcanization as the cause of bad aging and reduced the combined sulfur so much that oxidation deterioration was considerably reduced.

Also, it is probably true that the rubber itself was partially hurt by the long cooking required before the day of accelerators.

Our modern, wonderful tires would have been quite impossible without modern accelerators.

I should point out that litharge was used, particularly in the footwear business, long before organic accelerators were introduced. The litharge-cured footwear carried very little sulfur, and the vulcanized footwear aged wonderfully, partly because of the low sulfur and partly because the lead sulfide might have acted as an anti-oxidant.

Mercaptobenzothiazole or its derivatives are widely used accelerators today because they yield stocks that are well adapted to tire use.

The discovery of the accelerating action of mercaptobenzothiazole marked another milestone in rubber technology (9).

The industry uses for every 100 pounds of natural and synthetic rubber about 1½ pounds of organic accelerator. Making organic accelerators has taken some of our rubber companies into the chemical business; also, many of the chemical companies have interested themselves in the development and manufacture of organic accelerators. As a matter of fact, rubber chemicals which include organic accelerators and antioxidants use more aniline than the dyestuff business which was the big organic chemical business when I went to school.

Carbon Black

The demand of the growing automobile industry for

better-wearing tires presented the rubber industry with another challenge which was met by the introduction of carbon black into rubber compounding.

Carbon black was introduced into the tire treads about the time of the first World War, and its use has been universal ever since. There has been a lot of scientific work on why and how carbon blacks perform as well as they do. Recent improvements in carbon black have effected as much as 25% improvement in tread wear. The use of these new carbon blacks is an important factor in the constantly improving tread wear of our tires.

The rubber industry uses almost 94% of the total black produced. The rest goes into printing ink, paint, and other uses. Production of carbon black (see Figure 3) is one of the largest, if not the largest, of petrochemical businesses, and the study of how to make better carbon blacks for less money, or how to get something superior to carbon black, is one of the most complicated studies in surface chemistry.

Here the rubber industry has contented itself with allowing another industry to supply it with almost all of its third most important raw material; the first two are rubber and cord.

The rubber industry's annual carbon black bill is about \$100 million.

Antioxidants

The use of litharge or organic accelerators greatly improved the aging of vulcanized rubber, but not well enough to meet the demands of large commercial production of tires with better and better wearing qualities. This aging problem was the next challenge the rubber industry had to meet. Many workers had observed that various accelerators themselves improved the aging of rubber. Moureu and Dufraisse (10) published a lot of papers on how hydroquinone and the like could improve the aging of rubber.

In 1925 an antioxidant called VGB (11) was first

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placed on the market. Just as a matter of reminiscence, you might be interested in some of the troubles encountered in getting people to use antioxidants.

VGB was announced to the technical men of our company two years before it was put on the market. At that time data were presented to show that the aging could be greatly improved by using the antioxidant, but at the end of two years only two tons of antioxidant had actually been used. It seemed that the antioxidant cost 50¢ a pound and that was more than most stocks cost, so that the compounder had to increase the cost in order to get the better aging. Better aging, they claimed, did not increase the salability of the product. It was our old friend E. B. Curtis who showed that you could cheapen the stock enough to afford to put the antioxidant in and still have very much better average properties during the life of the article if the antioxidant were used.

Also, at about this time, the United States Government wanted to store a supply of gas masks, and the Government was very much interested in being told that antioxidants would keep the gas masks from deteriorating for a considerable period of time. Also, the Government had the problem of sending pure gum surgeon's gloves to the tropics where they deteriorated before they could be used very much. Here again the use of antioxidants appealed to the Government.

When the antioxidants were first put on the market, I believe the first use made of them was in inner tubes and in jar rings. In order to get the antioxidant used in jar rings I had to prove that the antioxidant would not poison the preserved fruit. After feeding various mice and dogs I personally finally ate such delicacies as preserved strawberries which had been cooked in contact with jar rings containing antioxidants.

But enough of the reminiscing.

I should point out that our distinguished colleagues Winkelmann and Gray (12) developed an antioxidant "AgeRite" that came on the market sometime later.

At about this time Sebrell and Bruson (13) published what I considered the outstanding article on antioxidants. They showed that natural rubber contained a naturally occurring "sterol-like" antioxidant which preserved the natural unvulcanized rubber from oxidation. If the naturally occurring antioxidant was extracted, the uncured natural rubber deteriorated very rapidly indeed. If the naturally occurring antioxidant was put back in the extracted rubber, it aged well again.

Synthetic rubber, of course, does not contain the naturally occurring antioxidant, and antioxidants have to be added in considerable amount to synthetic rubber to keep it from deteriorating. In this sense the antioxidants were a necessary forerunner for the synthetic rubber industry. Also, if our wartime stockpile of tires had not contained antioxidants, the tires would not have lasted so well and so cushioned our loss of natural rubber until we could get into production of synthetic rubber.

With the years, many new and superior antioxidants have been developed. It has been found that antioxidants

not only retard the ordinary deterioration of rubber, but retard the cracking of tire treads. A very considerable amount of the antioxidant is used for this particular purpose.

Modern rubber products carry on the average about 134 pounds of antioxidant for every 100 pounds of natural or synthetic rubber. The development and the manufacture of antioxidants have become a large chemical business, and antioxidants are used in many other industries than the rubber industry—in gasoline, plastics, and foods, to name only a few.

Tire Cord

Textiles have always been nearly as important as rubber to our industry. The need of improving the performance of the textiles that we use presented us with another major challenge.

It was early found that square woven fabric was not so good for the tire carcass as weftless fabric, and the change from square woven fabric accounted for a considerable improvement in tires.

The next great advance was S. H. Steere's high twist patent (14), which showed us how to improve greatly the performance of tire cord and how to reduce greatly the failure known as broken fabric.

At about this stage most of the tire companies began twisting their own cord, but they never went very far into the improving of cotton.

In the early Thirties tire cord rayon was introduced. Taking advantage of the greater strength of tire cord rayon, M. Castricum (15), of our company, was able to make the carcass of a truck tire 33% thinner, which meant less flexing, cooler running, and about 50% better average performance.

This advance had just been adequately demonstrated in small production when the second World War was started. Our natural rubber supply was cut off, and the only thing we had to make truck tires of was a little natural rubber and a lot of synthetic rubber. The Germans had worked a long time with synthetic rubber and had never learned how to make adequate truck tires carrying any considerable portion of synthetic rubber. Practically speaking, a synthetic truck tire carrying 65% of synthetic rubber would not much more than carry an empty truck.

United States Rubber Co. suggested that thin carcass rayon tires performed so much better with rubber, and they might make 65% synthetic rubber tires perform well enough. The Army Ordnance Department tested this out, and finally the Truman Committee directed that 400 million pounds of tire cord rayon be made available so that synthetic truck tires carrying tire cord rayon could be used. This was accomplished, and American civilian and military truck tires performed satisfactorily throughout the war.

Here again another industry has brought a major improvement to the rubber industry, and we have evaluated and accepted it. Tire cord rayon represents 50% of the entire rayon business, and it is another field of our scientific interest.

Nylon is still stronger even than tire cord rayon, and

⁴ B. F. Goodrich Co. trade mark.



Fig. 4. Air view of SBR plant being operated by U. S. Rubber at Port Neches, Tex.

we used it first for making stronger airplane tires and then for off-the-road tires, and finally for all sorts of tires. Nylon added so much strength and safety that its use has continually expanded in spite of the high cost. Currently, around 20% of tire cord is the synthetic fiber —nylon (16).

Synthetic Rubber

In the early 30's, Du Pont brought us neoprene (17). It opened a new chapter in the rubber business because of its oil resistance and other desirable properties. About this same time acrylonitrile rubber (Buna N) was introduced from Germany (18), and our industry learned how to use these nitrile rubbers to make bullet-sealing fuel cells during the war. Since the war we have learned how to use it to make tough plastic rubber blends.

In the late 30's, W. J. Sparks and R. M. Thomas, of Standard Oil of New Jersey, brought us butyl rubber (19). It held air remarkably well, and we learned how to use it so that it found wide acceptance in inner tubes.

When our supply of natural rubber was cut off early in the war, our industry did a wonderful job of cooperating with the chemical and the petroleum industries under the able leadership of the government to learn how to make synthetic rubber and to build and operate plants in which to make it.

We also learned how to make a kind of synthetic rubber that we could process practically in our plants. This had never been done before.

I have already referred to the fact that the thin rayon tire made it possible to use a considerable percentage of synthetic rubber in truck tires.

For the rubber industry, this was at once the most difficult and the proudest hour. We did the impossible, and we did it in the minimum of time with the maximum of cooperation in our highly competitive industry.

Great credit is due to the Office of Rubber Reserve of the Reconstruction Finance Corp. for the cooperative way in which it led the whole effort. Furthermore, great credit is due to all the members of the interested industries who gave so generously of their time during this most difficult period.

Thiokol's polysulfide polymer was one of the earliest of the oil resistant synthetics (20). It is still being used, and out of its chemistry has come the development of liquid rubbers that can be cast.

Silicone rubber is still another new synthetic (21) which can be used over a wide range of temperatures.

Several new and very intersting synthetics have come out of work with the fluorine compounds (22).

Urethane rubber sponge is becoming more and more of a factor in the foam sponge and rigid sponge market. I presume you all know that du Pont is testing out a new form of urethane rubber, called Adiprene, and that this can make a revolutionary improvement in tread wear (23).

Recently there has been a lot of interest in crystalline polymers including synthetic natural rubbers (24).

Plastics

Members of the rubber industry along with members of the chemical industry pioneered the production and the use of the important plastic polyvinyl chloride. Today more than one-half of the production capacity of this country for the manufacture of polyvinyl chloride is in plants owned and operated by rubber companies. These same companies use about 15% of the polyvinyl chloride produced. Many of the articles other than tires that used to be made out of a thermosetting plastic rubber are now made out of plastics. It is very hard to tell where the rubber industry ends and where the plastic industry begins. They are both rapidly growing industries based on synthetic high polymers and new methods of processing.

If it were not for the additional supply of synthetic rubber and the wider use of plastics by our industry, we could not have accomplished the 100% growth which we have experienced since the war.

Revolutionary Changes in Raw Materials

Since 1940 most of our industry's use of cotton has been changed over to rayon or nylon. Half of our industry's use of natural rubber has been changed over to synthetic rubber. A considerable percentage of our usage of elastomers has been replaced by the use of plastic.

I know of no other industry that has undergone such revolutionary changes in their raw materials as has the rubber industry. The technical burden of these changes was carried by you men of the ACS Rubber Division, and you can be very proud of the revolution that you have carried out so smoothly.

Acquisition of the GR-S Producing Facilities and What It Means

With the acquisition a year or so ago of the GR-S plants, the rubber industry has jumped right into the middle of the production of the largest-volume synthetic high polymer and the largest-volume synthetic organic chemical. (See Figure 4.) We have become so large a factor in the chemical business that we have to get ready to compete in this highly complicated, highly profitable chemical business. There are going to be lots

of phases to this competition, but I am particularly interested in the research and development phase.

The chemical industry has spent more than twice as much of their sales dollars on research and development as the rubber industry has been spending, and we have got to match its percentage of spending if we are going to remain competitive in this portion of our business. As we go into the production of synthetic rubber, we get ourselves more and more closely allied with the great and highly technical petroleum industry. There is a whole field of science and technology connected with the petroleum industry which is now our business.

We are close to the high polymer industry through our use of regenerated cellulose, as rayon, and through our use of nylon, as well as through our production and use of SBR and other synthetic rubbers and plastics. We are large factors in the petrochemical business through our purchase of carbon blacks and our use of synthetic rubber raw materials. We still have our rubber chemicals business.

Any way you look at it, our industry is right in the midst of the petrochemical, the high polymer chemical, and the rubber chemical business. These are three of the most profitable industries in America, and they are three industries that demand a high percentage of research and development. As I said before, we have just got to step up our research and development tempo.

We are now such large factors in the chemical business and in the research and development business that we have to take steps to be sure of at least two things: first, that there is enough fundamental research done preferably in our own country to support the industries in which we have become interested; second, that there is a sufficient supply of scientists to carry on our share of the increased research and development that will be demanded of us.

Let us first consider the fundamental research work. We can do that ourselves in our own laboratories, and much of it will be done there, but the experience in the past is that fundamental research work flourishes best in a more academic and less commercial atmosphere.

Harry L. Fisher (25) suggested that we should support rubber research institutes. His suggestion was a good one, and still is a good one, and I would just like to point out that the office of Rubber Reserve, RFC, practically acted like a great rubber institute during World War II and thereafter. ORR did the necessary scientific work to get GR-S on to a profitable production basis, and that was a great accomplishment. ORR also got Cold GR-S into production. Oil-extended GR-S was also developed and represents an outstanding accomplishment. A whole series of special synthetic latices was developed and marketed. The most important of these was the kind used for foam sponge.

We have also had a rubber reasearch institute in England, which has come up with methods of making graft polymers of natural rubber and the rather spectacular method of making graft polymers right in a special kind of tube. It is rather wonderful to think of being able to tear molecules apart and put them together again in different ways, according to the method Dr. Bateman described last spring (26).

The French Rubber Institute (27) has also come up with a way of directly reinforcing cast-latex articles, by the addition of resin forming ingredients to the latex before casting.

The Dutch Rubber Institute (28) has come up with chemical modification of natural rubber in the latex phase, leading to modified rubbers of higher molecular weight and more regular structure than by other methods.

It is very evident that the former office of Rubber Reserve, RFC, and these rubber research institutes have done excellent fundamental work and have come up with outstanding advances.

It is reasonably evident that if we wish to form and support research institutes of this sort to do fundamental work, over a term of years they will come up with comparable outstanding developments.

It seems to me that we can get additional fundamental scientific work done, and increase our supply of rubber scientists, by working out some way that some of the fundamental research we need can be carried out in the universities and supported by the rubber industry. This ought to mean that the young scientists who do the work in the universities would become available to the industry for further fundamental scientific work. This would be a necessary supplement to the proposal of a rubber research institute so ably put forth by Dr. Fisher.

I realize it will be hard to work out a plan that permits the university scientists to do science for science sake and still have them do work that is sufficiently basic to our industry to warrant diverting the stockholder's money for their support.

I would just like to propose that most enduring relations are based on *quid pro quo*; in plain English, to get about as much as you give. Therefore we have to work up some scheme by which the industrial sponsor gets fundamental work in our basic field and yet leaves the scientists untrampled in their academic freedom.

We are a major factor in the rather new and rapidly growing high polymer business. There is another equally new and equally growing business in our country, and that is atomic energy. Radiations may introduce a new kind of chemistry and new potentialities in high polymers. As the years go on, our two industries will undoubtedly cooperate to an increasing extent to great mutual benefit.

Summary and Conclusions

I envy you men your next few years in the rubber industry. We are in so many fields of science in which such rapid improvements are being made. We are going to have so many different kinds of synthetic rubber and plastics that we have just got to do a better job of finding out what properties are really needed for the best performance of our many products. This is a field of research in itself and one that probably has to be done by the rubber industry.

I see enormous improvements that are to be made in synthetic rubbers and synthetic plastics. Atomic energy and the scientific developments associated with it are

opening up large vistas of potential interest to our industry. The growth of automation can change the whole pattern of much of our industry. The scientific part of the rubber industry—the part that you and I are interested in-is one of the most exciting and productive areas of American industry, and it is going to get more so. The future of our industry will continue to be determined by how well we meet the challenges of

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Rubber Radiation Research Objectives

Three objectives of radiation research for the rubber industry were laid down by S. D. Gehman, head of the physics and electronics section, research division, The Goodyear Tire & Rubber Co., Akron, O., at the fifth annual Conference on Atomic Energy in Industry, March 14. Sponsored by the National Industrial Conference Board, the conclave was held in Convention Hall, Philadelphia, Pa., March 14 and 15.

Addressing a session concerning "New Products through Radiation Chemistry," Gehman listed the three objectives as (1) development of radiation-resistant elastomers and products; (2) use of radiation to crosslink or vulcanize elastomers and improve physical properties of plastics; and (3) application of radiation to initiate polymerizations and produce graft polymers and new varieties of synthetic rubber for special purposes.

Pointing out that materials and products of the rubber industry are relatively susceptible to the damaging, as well as the beneficial, effects of intense radiation, depending upon circumstances and dose, the speaker said it was possible that entirely new types of radiation-resistant elastomers must be synthesized for use in rubber components for prolonged service in an intense radiation environment.

In the meantime, compounding practices must be evaluated to secure optimum resistance to radiation damage. The possibility of adding radiation protective agents to rubber is currently being explored. Many products of the rubber industry are rubber-fabric compositions, with the fabric as the strength member, but the fabric is the weak link as far as resistance to radiation damage is concerned.

The Goodyear researcher stated that the production of elastomers by radiation catalysis of polymerization reactions has especial appeal in the light of results which have been reported in securing unusual graft polymers. There are potentialities here for new, specialpurpose rubbers, he further declared.

Although optimistic about the possibilities of the commercial application of intense radiation in the rubber industry, Gehman cautioned that these prospects can materialize only to the extent that cheap and abundant radiation sources become available for industry. He urged that development of such sources proceed concurrently with radiation application research.

Goodyear recently constructed a radiation laboratory adjacent to its main research building at Akron. The installation provides for storing the 2100 curie Co⁶⁰ source at the bottom of a water-filled well in a shielded cave. This permits equipment and experiments to be set up without remote manipulation, as well as enabling a large volume of radiation experiments to be carried on simultaneously. The cobalt source is raised above the surface of the water by an elevator for the irradiations.

All of the major rubber companies are currently engaging in some phase of radiation or atomic research, believing in its eventual commercial applicability.

⁵ Abstract only.

Curing Systems for Improved Aging Resistance of Rubber Vulcanizates—II*

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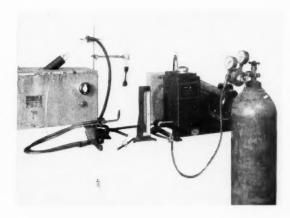


Fig. 4. Equipment used to seal rubber specimens in tubes under vacuum and free from air

AIR OVEN, BOMB, TEST TUBE AGING. Additional data on the accelerated aging of SBR and natural rubber vulcanizates prepared using two curing systems, (1) sulfur-accelerator, (2) accelerators only, are provided in Tables 12 and 13. Some of the aging equipment used is shown in Figure 3.† The aging media used were as indicated in the appropriate tables.

The remarkably good aging properties of both natural and SBR rubbers based on the non-free sulfur-curing systems are most evident from these data.

Only a small amount of deterioration was suffered by these compounds even after 10 days at 212° F. (Table 12). It is interesting to observe that the *sulfur-cured* SBR ages less at 212° F. than the sulfur-cured natural rubber, but at 158° F. the situation is reversed. The *accelerator-cured* SBR and natural rubbers resist aging equally as well at both 158 and 212° F. The agreement in aging values between the three test apparatus shown in Table 12 is excellent throughout. These data point up the erratic nature of tensile strength measurements with the resulting difficulty in using them for estimating aging and indicate the value of using changes in elongation as a means of estimating the aged condition of rubber compounds.

The data given in Table 13 again show the excellent age resistance of those SBR and natural rubber vulcanizates based on the non-free sulfur cures. It is further indicated that aging results were not substantially affected by the type of aging apparatus used for the test-

ing. With the possible exception of oxygen in the bomb test (ASTM D 942-50), the aging results were not affected by the atmosphere, or lack thereof, in which the aging was conducted.

Use of oxygen at 110 psi. pressure and a temperature of 158° F. as the aging medium caused an unusually large deterioration of tensile strength in the natural rubber compound with high sulfur (A6E) and a slight increase in elongation at constant load (NBS strain test) for all natural rubber compounds tested. The SBR compound did not exhibit this "abnormal" behavior in oxygen at 110 psi. and 158° F.

Importance of Oxygen in Accelerated Aging

The previous results have indicated that presence or absence of oxygen may not be an important factor in the aging of the diene rubbers and especially those prepared without using elemental sulfur. In an attempt to determine the relative importance of oxygen in accelerated aging of SBR vulcanizates, a series of tests was performed both in the presence and the absence of oxygen. In the first group of tests air oven aging of inhibited and uninhibited sulfur-accelerator and accelerator cured SBR was compared with aging of the same compounds totally immersed in water at a temperature of 210° F.

Since it was later determined that water at 210° F. has approximately 0.00003-gram of oxygen (equivalent to 0.02-milliliter oxygen/100 milliliters water) dissolved per 100 grams at a total pressure (aqueous tension plus partial pressure of oxygen) of 760 millimeters, the tests were repeated at 212° F. under continuous reflux. Results of these tests are given in Tables 14 through 17.

A new sample of uninhibited SBR¹² had to be used in these latter tests in water at 212° F., since the supply on hand of SBR was exhausted. It will be observed in the data, presented in Tables 14 through 17, that the stress-strain values for these compounds differed somewhat from the values obtained using the previous batch of uninhibited SBR. Vulcanizates based on this new batch of uninhibited polymer were shown in control tests, however, to have aging properties almost identical with the results obtained using the earlier uninhibited polymers.

^{*} Continued from our Mar., 1957, issue, p. 867. The opinions or assertions contained herein are not to be construed as official or reflecting the views of the Department of the Army.

[†] See our Mar. issue, p. 871.

¹² Prepared by Phillips Petroleum Co., Bartlesville, Okla.

Table 12. Extended Aging Tests Using Elemental Sulfur and Non-Elemental Sulfur Cures

		. (RIA 512)	Sulfur Cure		SBK Cp	u. (RIA 545	DA) —Accelera	itors Only
	Air Oven @		Air Oven @ Multi-Cell			ven @	Multi-Cell	
Aging			Oven	Test Tube		^	Oven	Test Tub
Time	212° F.	158° F.	(a 158° F.	@ 158° F.	212° F.	158° F.	@ 158° F.	@ 158° F
				Tensile, Psi.				
Original .	2780	2780	2780	2780	2570	2570	2570	2570
1 day	2730	2630	2720		2570	2520	2320	-
2 days	2540	2710	2680	_	2800	2680	2570	
3 days	2400	2580	2660	2740	2640	2460	2560	2590
6 days	2410	2600	-	2600	2710	2420	2410	2610
7 days	2390	2780	2750	2840	2680	2410	2600	2460
8 days	_	2760	2990			2590	2520	
10 days	2530	2850	2840	2730	2700	2540	2540	2480
			1	Iltimate Elongatio	on CZ			
Original	510	E10				E70	570	570
1 day		510	510	510	570	570		370
2 days	350	420	450		490	520	470	
3 days	300	410	410		490	550	500	530
6 days	280 250	380	380	360	480	520	520 490	540
7 days		350		350	480	510		520
8 days	240	370	360	360	460	510	540	
10 days	240	360	380	250	460	490 490	470 470	520
10 days	240	370	380	350	460	490	470	320
				longation at 400 F				
Original	131	131	131	131	153	153	153	153
1 day	91	120	118	119	140	150	151	152
2 days	83	111	108	110	135	150	150	152
3 days	80	107	103	105	132	150	150	152
6 days	69	97	99	96	126	147	147	151
7 days	68	96	98	95	125	145	146	151
8 days	66	94	97	94	125	145	146	151
10 days	63	93	95	91	125	145	146	151
	Natural Rubb	per (A6E Cpc	i.)—Sulfur Cu	ге		Rubber (A1 C	cpd.)—Accelera	ators Only
		ven @	Multi-Cell				Multi-Cell	
Aging Time				Test Tube @ 158° F.	Natural F			Test Tube
Aging	Air O	ven @	Multi-Cell Oven	Test Tube @ 158° F.	Natural F	ven @	Multi-Cell Oven	Test Tube
Aging Time	Air O	ven @ 158° F.	Multi-Cell Oven @ 158° F.	Test Tube @ 158° F. Tensile, Psi.	Natural F Air O	ven @ 158° F .	Multi-Cell Oven @ 158 F.	Test Tube
Aging Time	Air O 212° F.	ven @ 158° F. 3340	Multi-Cell Oven @ 158° F.	Test Tube (a 158° F. Tensile, Psi. 3340	Air O 212° F.	158° F .	Multi-Cell Oven @ 158 F.	Test Tube (a 158° F.
Aging Time Original 1 day	Air O	ven @ 158° F. 3340 3660	Multi-Cell Oven (a 158° F.	Test Tube @ 158° F. Tensile, Psi. 3340	Natural F Air O 212° F. 2470 2520	ven @ 158° F. 2470 2530	Multi-Cell Oven @ 158 F. 2470 2490	Test Tube (a 158° F.
Aging Time Original 1 day 2 days	Air O	158° F. 3340 3660 3540	Multi-Cell Oven (a 158° F. 3340 3510 3650	Test Tube @ 158° F. Tensile, Psi. 3340	Natural F Air O 212° F. 2470 2520 2350	ven @ 158° F. 2470 2530 2370	Multi-Cell Oven @ 158° F. 2470 2490 2200	Test Tube (a 158° F.
Aging Time Original 1 day 2 days 3 days	Air O	3340 3660 3540 3520	Multi-Cell Oven @ 158° F. 3340 3510 3650 3500	Test Tube @ 158° F. Tensile, Psi. 3340 3370	Natural F Air O 212° F. 2470 2520 2350 2240	2470 2530 2370 2410	Multi-Cell Oven @ 158 F. 2470 2490 2200 2200	Test Tube (a 158° F.
Aging Time Original 1 day 2 days 3 days 6 days	Air O 212 F. 3340 3280 2880 2110	158° F. 3340 3660 3540 3520 3360	Multi-Cell Oven @ 158° F. 3340 3510 3650 3500	Test Tube @ 158° F. Tensile, Psi. 3340 3370 3390	Air O 212° F. 2470 2520 2350 2240	2470 2530 2370 2410 2310	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200	Test Tube @ 158° F. 2470 2430 2450
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days	Air O 212 F. 3340 3280 2880 2110 395	158° F. 3340 3660 3540 3520 3360 3370	Multi-Cell Oven @ 158° F. 3340 3510 3650 3500 — 3440	Test Tube @ 158° F. Tensile, Psi. 3340 — — 3370 3390 3430	Natural F Air O 212° F. 2470 2520 2350 2240 — 2100	ven @ 158° F. 2470 2530 2370 2410 2310 2540	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 2190	Test Tube @ 158° F. 2470 2430 2450 2380
Aging Time Driginal 1 day 2 days 3 days 6 days 6 days 8 days	Air O	158° F. 3340 3660 3540 3520 3360 3370 3370	Multi-Cell Oven @ 158° F. 3340 3510 3650 3500 3440 3490	Test Tube (a 158° F. Tensile, Psi. 3340 — — — 3370 3390 3430	Natural F Air O 212° F. 2470 2520 2350 2240 2100	2470 2530 2370 2410 2310 2540 2480	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 2190 2090	Test Tube @ 158° F. 2470 2430 2450
Aging Time Driginal 1 day 2 days 3 days 6 days 6 days 8 days	Air O 212 F. 3340 3280 2880 2110 395	158° F. 3340 3660 3540 3520 3360 3370	Multi-Cell Oven (a 158° F. 3340 3510 3650 3500 3440 3490	Test Tube @ 158° F. Tensile, Psi. 3340 — — — 3370 3390 3430 — —	Natural F Air O 212° F. 2470 2520 2350 2240 —————————————————————————————————	ven @ 158° F. 2470 2530 2370 2410 2310 2540	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 2190	Test Tube (a 158° F. 2470 2430 2450 2380
Aging Time Driginal 1 day 2 days 3 days 6 days 6 days 7 days 8 days 0 days	Air O	3340 3660 3540 3520 3360 3370 3370 3390	Multi-Cell Oven (a 158° F. 3340 3510 3650 3500 3440 3490 —	Test Tube @ 158° F. Tensile, Psi. 3340 — — — 3370 3390 3430 — — — Itimate Elongatio	Natural F Air O 212° F. 2470 2520 2350 2240 2100 1730	2470 2530 2370 2410 2310 2540 2480 2310	Multi-Cell Oven @ 158 F. 2470 2490 2200 2200 2190 2090	Test Tube (a 158° F. 2470 ————————————————————————————————————
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days 0 days	Air O 212 F. 3340 3280 2880 2110	158° F. 3340 3660 3540 3520 3360 3370 3370 3390	Multi-Cell Oven @ 158° F. 3340 3510 3650 3500 3440 3490 U	Test Tube @ 158° F. Tensile, Psi. 3340 — — — 3370 3390 3430 — —	Natural F Air O 212° F. 2470 2520 2350 2240 2100 1730 n, % 680	2470 2530 2370 2410 2310 2540 2480 2310	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 — 2190 2090 — 680	Test Tube (a 158° F. 2470 2430 2450 2380
Aging Time Original 1 day 2 days 3 days 6 days 7 days 8 days 10 days	Air O 212 F. 3340 3280 2880 2110 395 205	3340 3660 3540 3520 3360 3370 3370 3390	Multi-Cell Oven @ 158° F. 3340 3510 3650 3500 — 3440 3490 — U	Test Tube @ 158° F. Tensile, Psi. 3340 — — — 3370 3390 3430 — — — Itimate Elongatio	Natural F Air O 212° F. 2470 2520 2350 2240 — 2100 — 1730 n, % 680 630	2470 2530 2370 2410 2310 2540 2480 2310 680 640	Multi-Cell Oven @ 158 F. 2470 2490 2200 2200 — 2190 2090 — 680 650	Test Tube (a 158° F. 2470 ————————————————————————————————————
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days 10 days	Air O 212 F. 3340 3280 2880 2110	158° F. 3340 3660 3540 3520 3360 3370 3370 3390	Multi-Cell Oven @ 158° F. 3340 3510 3650 3500 3440 3490 U	Test Tube (a 158° F. Tensile, Psi. 3340 — — 3370 3390 3430 — — ltimate Elongatio 600	Natural F Air O 212° F. 2470 2520 2350 2240 2100 1730 n, % 680	2470 2530 2370 2410 2310 2540 2480 2310	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 — 2190 2090 — 680	Test Tube (a 158° F. 2470 ————————————————————————————————————
Aging Time Original 1 day 2 days 3 days 6 days 7 days 8 days 10 days	Air O 212 F. 3340 3280 2880 2110 395 205	3340 3660 3540 3520 3360 3370 3370 3390	Multi-Cell Oven @ 158° F. 3340 3510 3650 3500 — 3440 3490 — U	Test Tube (a 158° F. Tensile, Psi. 3340	Natural F Air O 212° F. 2470 2520 2350 2240 — 2100 — 1730 n, % 680 630	2470 2530 2370 2410 2310 2540 2480 2310 680 640	Multi-Cell Oven @ 158 F. 2470 2490 2200 2200 — 2190 2090 — 680 650	Test Tube (a 158° F. 2470 2430 2450 2380 680
Aging Time Driginal 1 day 2 days 3 days 6 days 6 days 8 days 9 days 9 days 1 day 2 days 3 days	Air O 212 F. 3340 3280 2880 2110 395 205 600 580 500	3340 3660 3540 3520 3360 3370 3370 3390 600 630 600	Multi-Cell Oven @ 158° F. 3340 3510 3650 3500 — 3440 3490 — U 600 610 610	Test Tube (a 158° F. Tensile, Psi. 3340	Natural F Air O 212° F. 2470 2520 2350 2240 —————————————————————————————————	2470 2530 2370 2410 2310 2540 2480 2310 680 640 660	Multi-Cell Oven @ 158 F. 2470 2490 2200 2200 — 2190 2090 — 680 650 650	Test Tube (a 158° F 2470 2430 2450 2380 680
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days 0 days Original 1 day 2 days 3 days 6 days 7 days	Air Of 212 F. 3340 3280 2880 2110 395 205 600 580 500 440	3340 3360 3340 33520 3360 3370 3370 3390 600 630 600 590	Multi-Cell Oven @ 158° F. 3340 3510 3650 3500 — 3440 3490 — 000 610 610 610 570	Test Tube @ 158° F. Tensile, Psi. 3340 3370 3390 3430 Eltimate Elongatio 600	Natural F Air O 212° F. 2470 2520 2350 2240 — 2100 — 1730 n, % 680 630 640 630	2470 2530 2370 2410 2310 2540 2480 2310 680 640 660 660	Multi-Cell Oven @ 158 F. 2470 2490 2200 2200 — 2190 2090 — 680 650 650 650	Test Tube (a 158° F 2470 2430 2450 2380 680
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days 9 days 9 days 1 day 2 days 3 days 6 days 8 days 9 days 9 days 1 day 1 day 2 days 6 days 7 days 8 days 8 days	Air O 212 F. 3340 3280 2880 2110 395 205 600 580 500 440 230	3340 3660 3540 3520 3360 3370 3370 3370 600 630 600 590 570 570	Multi-Cell Oven (a) 158° F. 3340 3510 3650 3500 3440 3490 U 600 610 610 570	Test Tube (a 158° F. Tensile, Psi. 3340	Natural F Air O 212° F. 2470 2520 2350 2240 —————————————————————————————————	2470 2530 2370 2410 2310 2540 2480 2310 680 640 660 660 660 650	Multi-Cell Oven (a) 158° F. 2470 2490 2200 2200 2200 — 680 650 650 650	Test Tube (a 158° F) 2470 ————————————————————————————————————
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days 0 days Original 1 day 2 days 3 days 6 days 7 days 8 days 8 days 9 days	Air O 212 F. 3340 3280 2880 2110	158° F. 3340 3660 3540 3520 3360 3370 3390 600 630 600 590 570 570	Multi-Cell Oven (a) 158° F. 3340 3510 3650 3500 3440 3490 U 600 610 610 570 580	Test Tube (a 158° F. Tensile, Psi. 3340 ———————————————————————————————————	Natural F Air O 212° F. 2470 2520 2350 2240 —————————————————————————————————	2470 2530 2370 2410 2310 2540 2480 2310 680 640 660 660 650 650	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 — 2190 2090 — 680 650 650 650 650 — 610	Test Tube (a 158° F 2470 2430 2450 2380 680 660 650
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days 9 days 9 days 1 day 2 days 3 days 6 days 8 days 9 days 9 days 1 day 1 day 2 days 6 days 7 days 8 days 8 days	Air O 212 F. 3340 3280 2880 2110 395 205 600 580 500 440 230	3340 3660 3540 3520 3360 3370 3370 3370 600 630 600 590 570 570	Multi-Cell Oven @ 158° F. 3340 3510 3650 3500 — 3440 3490 — U 600 610 610 610 570 — 580 590	Test Tube (a 158° F. Tensile, Psi. 3340 ———————————————————————————————————	Natural F Air O 212° F. 2470 2520 2350 2240 —————————————————————————————————	2470 2530 2370 2410 2310 2540 2480 2310 680 640 660 650 650 680	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 — 2190 2090 — 680 650 650 650 650 650 650 630	Test Tube (a 158° F 2470 2430 2450 2380 680 660 650 650
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 9 days 1 day 2 days 8 days 0 days Original 1 day 2 days 3 days 6 days 7 days 8 days 9 days 9 days 1 day 9 days	Air O 212 F. 3340 3280 2880 2110 205 600 580 500 440 230 130	158° F. 3340 3660 3540 3520 3360 3370 3390 600 630 600 590 570 570 570	Multi-Cell Oven (2) 158° F. 3340 3510 3650 3500 3440 3490 U 600 610 610 610 570 580 590 % Ele	Test Tube (a 158° F. Tensile, Psi. 3340 ———————————————————————————————————	Natural F Air O 212° F. 2470 2520 2350 2240 2100 1730 n, % 680 630 640 630 640 630 640 630 6580 8si. (NBS)	2470 2530 2370 2410 2310 2540 2480 2310 680 640 660 650 650 680 680	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 — 2190 2090 — 680 650 650 650 650 650 — 610 630 —	Test Tube (a 158° F 2470 2430 2450 2380 680 660 650 650 660
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days 0 days Original 1 day 2 days 3 days 6 days 7 days 8 days 9 days 9 days	Air O 212 F. 3340 3280 2880 2110 395 205 600 580 500 440 230 130	3340 3360 3540 3520 3360 3370 3370 3390 600 630 600 590 570 570 570	Multi-Cell Oven (2) 158° F. 3340 3510 3650 3500 3440 3490 U 600 610 610 610 570 580 590 % Ele 160	Test Tube (a 158° F. Tensile, Psi. 3340	Natural F Air O 212° F. 2470 2520 2350 2240 —— 2100 —— 1730 680 630 640 630 —— 600 —— 580 esi. (NBS) 321	2470 2530 2370 2410 2310 2540 2480 2310 680 640 660 650 650 650 680 680	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 — 2190 2090 — 680 650 650 650 650 650 — 610 630 —	Test Tube (a 158° F 2470 2430 2450 2380 680 660 650 650 660
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days 0 days Driginal 1 day 2 days 3 days 6 days 7 days 8 days 8 days 9 days 9 days 1 day 1 day 1 day 2 days 1 day 2 days 3 days 6 days 9 days 1 day 1 day 1 day	Air O 212 F. 3340 3280 2880 2110 395 205 600 580 500 440 130	158° F. 3340 3660 3540 3520 3360 3370 3370 3370 570 570 570 160 158	Multi-Cell Oven (a) 158° F. 3340 3510 3650 3500 — 3440 3490 — 0600 610 610 610 570 — 580 590 — % Ele 160 158	Test Tube (a 158° F. Tensile, Psi. 3340	Natural F Air O 212° F. 2470 2520 2350 2240 —————————————————————————————————	2470 2530 2370 2410 2310 2540 2480 2310 680 640 660 650 650 650 680 680	Multi-Cell Oven @ 158 F. 2470 2490 2200 2200 — 2190 2090 — 680 650 650 650 650 — 610 630 — 321 319	Test Tube (a 158° F 2470 2430 2450 2380 680 660 650 660 650 660
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days 0 days Driginal 1 day 2 days 3 days 6 days 7 days 8 days 9 days 1 day 1 day 2 days 9 days 9 days 1 day 2 days	Air O 212 F. 3340 3280 2880 2110 395 205 600 580 500 440 230 130	158° F. 3340 3660 3540 3520 3360 3370 3370 3390 600 630 600 590 570 570 570 570 160 158 157	Multi-Cell Oven (a) 158° F. 3340 3510 3650 3500 3440 3490 580 590 580 590 158 157	Test Tube @ 158° F. Tensile, Psi. 3340 — — 3370 3390 3430 — — — ltimate Elongatio 600 — — 580 580 580 580 570 congation @ 400 P 160 157 155	Natural F Air O 212° F. 2470 2520 2350 2240 — 2100 — 1730 nn, % 680 630 640 630 — 600 — 580 si. (NBS) 321 320 317	2470 2530 2370 2410 2540 2480 2310 680 640 660 660 650 650 680 880	Multi-Cell Oven (a) 158° F. 2470 2490 2200 2200 2200 — 2190 2090 — 680 650 650 650 650 650 — 610 630 — 321 319 318	Test Tube (a 158° F) 2470 ————————————————————————————————————
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days Original 1 day 2 days 6 days 7 days 8 days 9 days 9 days 1 day 2 days 9 days 1 day 2 days 9 days 9 days 1 day 9 days	Air O 212 F. 3340 3280 2880 2110 395 205 600 580 500 440 230 130	158° F. 3340 3660 3540 3520 3360 3370 3390 600 630 600 590 570 570 570 570 160 158 157 156	Multi-Cell Oven (a) 158° F. 3340 3510 3650 3500 — 3440 3490 — 000 610 610 610 570 — 580 590 — 7% Eld 160 158	Test Tube (a 158° F. Tensile, Psi. 3340 ———————————————————————————————————	Natural F Air O 212° F. 2470 2520 2350 2240 —————————————————————————————————	2470 2530 2370 2410 2310 2540 2480 2310 680 640 660 660 650 650 680 680	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 —— 2190 2090 —— 680 650 650 650 650 —— 610 630 —— 321 319 318 317	Test Tube (a 158° F 2470 ————————————————————————————————————
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days 0 days Driginal 1 day 2 days 3 days 6 days 7 days 8 days 9 days 1 day 2 days 2 days 3 days 6 days 7 days 8 days 9 days 1 day 9 days 1 day 9 days 9 days 1 day 9 days 9 days 9 days 1 day 9 days	Air O 212 F. 3340 3280 2880 2110 395 205 600 580 500 440 230 130 160 147 147 144 broke	158° F. 3340 3660 3540 3520 3360 3370 3390 600 630 600 590 570 570 570 570 160 158 157 156 148	Multi-Cell Oven (2) 158° F. 3340 3510 3650 3500 3440 3490 U 600 610 610 610 570 580 590 7 Eld 160 158 157 156 147	Test Tube (a 158° F. Tensile, Psi. 3340 ———————————————————————————————————	Natural F Air O 212° F. 2470 2520 2350 2240 — 2100 — 1730 n, % 680 630 640 630 — 600 — 580 si. (NBS) 321 320 317 302 296	2470 2530 2370 2410 2310 2540 2480 2310 680 640 660 650 650 650 680 680	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 — 2190 2090 — 680 650 650 650 650 650 — 610 630 — 321 319 318 317 313	Test Tube (a 158° F 2470 ————————————————————————————————————
Aging Time Driginal 1 day 2 days 3 days 6 days 7 days 8 days 10 days Driginal 1 day 2 days 3 days 6 days 7 days	Air O 212 F. 3340 3280 2880 2110 395 205 600 580 500 440 230 130	158° F. 3340 3660 3540 3520 3360 3370 3390 600 630 600 590 570 570 570 570 160 158 157 156	Multi-Cell Oven (a) 158° F. 3340 3510 3650 3500 — 3440 3490 — 000 610 610 610 570 — 580 590 — 7% Eld 160 158	Test Tube (a 158° F. Tensile, Psi. 3340 ———————————————————————————————————	Natural F Air O 212° F. 2470 2520 2350 2240 —————————————————————————————————	2470 2530 2370 2410 2310 2540 2480 2310 680 640 660 660 650 650 680 680	Multi-Cell Oven @ 158° F. 2470 2490 2200 2200 —— 2190 2090 —— 680 650 650 650 650 —— 610 630 —— 321 319 318 317	Test Tube (a 158° F. 2470 ————————————————————————————————————

TABLE 13. EFFECT OF TEST MEDIA AND APPARATUS ON AGING OF SBR AND NATURAL RUBBER

				Na	atural Rub	ber		SBR	
A pparatus	Media or ASTM No.	Aging Time	Aging Temp. °F.	No Sulfur A1	Low Sulfur A8	High Sulfur A6E	No Sulfur S45DA	High Sulfur S12	High Sulfur S27
						Tensile	, Psi.		
Original				2470	3240	3340	2570	2780	2680
Air oven	D 573-52	7 days	158	2540	2990	3370	2410	2780	2350
Multi-cell oven	E 95-52T	7 days	158	2190	3180	3440	2600	2750	2380
Test tube aging	D 865-52T	7 days	158	2380	3220	3430	2460	2840	2370
Confined system	air	7 days	158	2480	2950	3510	2510	2750	2420
Test tube w/cir-	oxygen	7 days	158	2380	2970	3430	2470	2670	2410
culation of 5	air	7 days	158	2620	3150	3420	2460	2820	2350
ml. per min.	nitrogen	7 days	158	2550	3150	3420	2460	2700	2430
ASTM D 942-50,	oxygen	7 days	158	2200	2830	2200	2400	2830	2440
bomb at 110,	air	7 days	158	2540	2730	3100	2570	2760	2400
psi.	nitrogen	7 days	158	2520	2790	3560	2470	2690	2340
37 (06 = :	carbon dioxide	7 days	158					2790	2280
Vacuum (26.5 in. of Hg)	D 550 50	7 days	158	2390	3340	3500	2600	2880	2510
Air oven	D 573-52	70 hrs.	212	2240	2700	2110	2640	2400	2180
						300% Mod	ulus, Psi.		
Original				190	2050	1010	1160	1500	1050
Air oven	D 573-52	7 days	158	240	2190	1310	1360	2300	1400
Multi-cell oven	E 95-52T	7 days	158	250	2220	1410	1250	2280	1450
Test tube	D 865-52T	7 days	158	250	2240	1290	1200	2280	1380
Confined system Vacuum (26.5 in.	air	7 days	158	250	2270	1260	1380	2240	1450
of Hg)		7 days	158	260	2150	1190	1300	2210	1450
Test tube w/cir-	oxygen	7 days	158	260	2150	1190	1300	2210	1450
culation of 5	air	7 days	158	195	2200	1280	1290	2270	1460
ml. per min.	nitrogen	7 days	158	250	2210	1260	1350	2320	1490
ASTM D 942-50,	oxygen	7 days	158	235	1850	1000	1350	2160	1380
bomb at 110	air	7 days	158	240	2110	1250	1350	2180	1460
psi.	nitrogen	7 days	158	250	2200	1430	1390	2280	1570
Air oven	CO ₂ D 573-52	7 days 70 hrs.	158 212	245	2530	1210	1550	2100 none	1520 1800
THE OVER	D 373-32	70 ms.	212	243		Elongation, U			1000
Original				680	410	600	570	510	600
Air oven	D 573-52	7 days	158	650	370	570	510	370	450
Multi-cell oven	E 95-52T	7 days	158	610	390	580	540	360	460
Test tube	D 865-52T	7 days	158	650	390	580	520	360	460
Confined system	air	7 days	158	670	370	590	500	370	460
Test tube w/cir-	oxygen	7 days	158	660	390	590	520	370	470
culation of 5 ml. per min.	air	7 days	158	660	390	580	500 500	380 350	450 460
	nitrogen	7 days	158	670	390	590			
ASTM D 942-50, bomb at 110	oxygen air	7 days 7 days	158 158	670 680	430 360	570 570	510 530	400 360	490 450
psi,	nitrogen	7 days	158	670	360	570	490	360	430
Port	CO ₂	7 days	158	_			-	400	420
Vacuum (26.5 in.		7 days	158	650	410	580	520	410	490
of Hg) Air oven	D 573-52	70 hrs.	212	630	310	440	480	280	280
						Hardness,	Shore A		
Original				44	73	61	64	66	56
Air oven	D 573-52	7 days	158	46	77	65	66	71	60
Multi-cell oven	E 95-52T	7 days	158	45	76	65	65	69	59
Test tube	D 865-52T	7 days	158	45	77	63	66	69	59
Confined system	air	7 days	158	45	75	64	66	70	59
Vacuum (26.5 in. of Hg)		7 days	158	44	75	63	65	66	58
Test tube w/cir-	oxygen	7 days	158	45	75	60	64	69	60
culation of 5	air	7 days	158	45	74	61	63	70	59
ml. per min.	nitrogen	7 days	158	46	74	62	65	69	60
ASTM D 942-50,	oxygen	7 days	158	44	74	62	66	67	59
bomb at 110	air	7 days	158	45	76	62	66	68	58
psi.	nitrogen	7 days	158	45	76	63	66	68	59
	CO ₂	7 days	158	-			and the same of	69	59
Air oven	D 573-52	70 hrs.	212	45	76	62	67	74	62

				Na	tural Rub	ber		SBR	
Apparatus	Media or ASTM No.	Aging Time	Aging Temp. °F.	No Sulfur A1	Low Sulfur A8	High Sulfur A6E	No Sulfur S45DA	High Sulfur S12	High Sulfur S27
					% E	ongation (400 Psi. (1	NBS)	
Original				321	94	160	153	131	163
Air oven	D 573-52	7 days	158	314	88	147	145	96	135
Multi-cell oven	E 95-52T	7 days	158	312	88	144	146	98	136
Test tube	D 865-52T	7 days	158	320	87	144	151	95	136
Confined system	air	7 days	158	317	84	146	140	97	136
Vacuum (26.5 in. of Hg)		7 days	158	322	90	148	145	110	145
Test tube w/cir-	oxygen	7 days	158	317	88	147	144	102	139
culation of 5	air	7 days	158	316	87	146	143	95	137
ml. per min.	nitrogen	7 days	158	317	88	147	142	96	135
ASTM D 942-50.	oxygen	7 days	158	331	100	162	145	97	137
bomb at 110	air	7 days	158	320	90	146	144	96	134
psi.	nitrogen	7 days	158	316	85	137	145	98	130
	CO ₂	7 days	158	*******		_	-	109	134
Air oven	D 573-52	70 hrs.	212	302	77	144	132	80	112

TABLE 14. AGING OF UNINHIBITED SBR* IN AIR OVEN AND IN WATER AGING OF UNINHIBITED SULFUR CURED

Property Tested	Environment	Orig- inal	3 Days	7 Days	14 Days	
Tensile, psi.	air (212° F.) water (210° F.) (212° F.)†	3190 3190 3005	2120 2360 2905	815 1245 2785	665 2735	
200% Modulus, psi.	air (212° F.) water (210° F.) (212° F.)†	560 560 905	1845 1170 1450	1540	1590	
300% Modulus, psi.	air (212° F.) water (210° F.) (212° F.)†	1355 1355 1785	2610	2740	2640	
% Elongation	air (212° F.) water (210° F.) (212° F.)†	520 520 510	220 290 330	80 190 310	130 290	
Hardness	air (212° F.) water (210° F.) (212° F.)†	66 66 68	74 66 68	82 71 70	72 70	
Strain @ 400 psi.	air (212° F .)	143	75	all broke	***	
	water (210 $^{\circ}$ F .)	143	95	92	all broke	
	$(212^{\circ} \text{ F.})^{\dagger}$	127	96	91	90	

^{*} Special SBR 1500 containing no antioxidant-RIA S77DA

† New sample of uninhibited SBR used for these tests.

An examination of the data in these four tables reveals the following principal conclusions:

1. The non-free sulfur cured SBR compounds have better age resistance than the free sulfur cured com-

2. The sulfur-accelerator cured rubber is extremely sensitive to the presence of oxygen in the aging atmosphere since much more aging resulted in the water at 210 than at 212° F.

3. Even in the complete absence of oxygen, considerable aging takes place in the sulfur-accelerator cured specimens.

4. The inhibited non-free sulfur cured rubber shows only a relatively small degree of aging, whether oxygen

TABLE 15. AGING OF UNINHIBITED NON-FREE SULFUR CURED SBR* IN AIR OVEN AND IN WATER

Property Tested	Environment	Orig- inal	3 Days	7 Days	14 Days	21 Days
Tensile, psi.	air (212° F.) water (210° F.) (212° F.)†	2835 2835 2840	2870 2840 2790	1920 2625 2940	1960 2315 2695	915 1230 2195
200% Modu- lus, psi.	air (212° F.) water (210° F.) (212° F.)†	265 265 335	610 500 505	640 625 595	845 690 730	845 710
300% Modu- lus, psi.	air (212° F.) water (210° F.) (212° F.)†	760 760 690	1330 1285 1270	1510 1510 1440	1805 1770 1665	1530
% Elon- gation	air (212° F.) water (210° F.) (212° F.)†	580 580 580	460 460 450	400 390 450	320 340 390	140 240 340
Hardness	air (212° F.) water (210° F.) (212° F.)†	62 62 60	62 62 61	65 63 61	70 67 60	78 65 60
Strain @ 400 psi.		198 198 195	155 156 163	150 150 156	126 139 152	110 150

^{*} Special polymer-SBR 1500 containing no antioxidant-RIA S77DAC compound.
† New sample of uninhibited SBR used for these tests.

is present or absent.

5. The inhibited and uninhibited compounds within each particular curing system aged approximately equally in the absence of oxygen.

To determine further the effect of aging in the absence of oxygen for sulfur cured SBR, a group of tests was conducted using evacuated Carius tubes. The samples of compounds S77D containing one part PBNA, and S77DA with no antioxidant were placed in heated tubes, and the air was evacuated to less than 0.01-millimeter (Figure 4). Next the tubes were flushed out five times with oxygen-free nitrogen and evacuated to 0.01-millimeter pressure or less between each flushing. After the final flushing, the tubes were sealed under vacuum.

The tubes were placed into an air oven for various

TABLE 16. AGING OF INHIBITED SULFUR CURED SBR* IN AIR OVEN AND IN WATER

Property Tested	Environment	Orig- inal	3 Days	7 Days	14 Days	21 Days
Tensile, psi.	air (212° F.) water (210° F.) (212° F.)†	2950 2950 2855	2610 2635 2945	2640 2610 2710	1950 2040 2725	1130 1575 2645
Modu- lus, psi.	air (212° F.) water (210° F.) (212° F.)†	595 595 870	1170 1060 1345	1595 1040 1535	1260 1505	1290 1105
300% Modu- lus, psi.		1240 1240 1660	2300 1930 2495	2060 2610	2685	2440
% Elon- gation	air (212° F.) water (210° F.) (212° F.)†	590 590 490	330 370 360	270 350 310	160 280 300	80 220 320
Hardness	air (212° F .) water (210° F .) (212° F .)†	66 66	70 67 69	74 67 69	76 68 69	77 67 64
Strain @ 400 psi.	air (212° F.) water (210° F.) (212° F.)†	144 144 130	88 105 99	80 99 94	55 93 92	88

^{*} Special uninhibited SBR 1500 with one part PBNA added—RIA \$77D compound.

† New sample of uninhibited SBR used for these tests.

TABLE 17. AGING OF INHIBITED NON-FREE SULFUR CURED SBR* IN AIR OVEN AND IN WATER

Property Tested		Orig- inal	3 Days	7 Days	14 Days	21 Days
Tensile, psi.	air (212° F.) water (210° F.) (212° F.)†		2600 2700 2235	2580 2925 2480	2445 2515 2305	1820 2250 2345
	air (212° F.) water (210° F.) (212° F.)†		435 555 695		705 655 685	730 735 805
300% Modu- lus, psi.	air (212° F.) water (210° F.) (212° F.)†	930 930 835	1085 1080 1240	1390 1250 1300	1505 1565 1445	1615 1620 1710
% Elon- gation	air (212° F.) water (210° F.) (212° F.)†	650 650 550	450 490 440	460 500 440	420 470 410	330 380 360
Hardness	air (212° F.) water (210° F.) (212° F.)†	64 64 61	64 64 62	66 64 62	66 62 62	66 63 62
	air (212° F.) water (210° F.) (212° F.)†			126 131 150	123 126 145	122 115 128

^{*}Special uninhibited polymer with one part PBNA added—RIA \$77CD compound.

† New sample of uninhibited SBR used for these tests.

TABLE 18. AGING OF INHIBITED AND UNINHIBITED SULFUR CURED SBR VULCANIZATES IN THE ABSENCE OF OXYGEN (SEALED EVACUATED TUBES)

		d Poly	mer an	d One
	Aged 96	Aged 14	Aged 70	Aged 14
	Hrs.	Days	Hrs.	Days
Orig-	(a)	(a)	(a	(a)
inal	212°	212°	300°	300°
(Blank)	F.	F.	F.	F.
2890	3015	2725	2800	2665
1065	1525	1605	1225	1360
1915	2705		2375	2515
460	360	300	460	310
65	67	68	69	66
122	91	84	102	94
	inhibi	ted P	olyme	-No
2980	2870	2850	2730	2175
1120	1625	1740	1425	1750
1955	2870		2655	
460	300	290	310	230
64	69	70	70	71
116	90	85	102	83
	inal (Blank) 2890 1065 1915 460 65 122 2980 1120 1955 460 64	Aged 96 Hrs. Orig- inal 212° (Blank) F. 2890 3015 1065 1525 1915 2705 460 360 65 67 122 91 S77D inhibi Ant 2980 2870 1120 1657 1955 2870 460 300 64 69	Aged Aged 96 14 Hrs. Days Orige (a (a) inal 212 212 (Blank) F. F. 2890 3015 2725 1065 1525 1605 1915 2705 460 360 300 65 67 68 122 91 84 S77DA Cominhibited F Antioxidar 2980 2870 2850 1120 1625 1740 1955 2870 460 300 290 64 69 70	96 14 70 Hrs. Days Hrs. Orig- inal 212° 212° 300° (Blank) F. F. F. 2890 3015 2725 2800 1065 1525 1605 1225 1915 2705 2375 460 360 300 460 65 67 68 69 122 91 84 102 S77DA Compound inhibited Polymer Antioxidant Add 2980 2870 2850 2730 1120 1625 1740 1425 1955 2870 2655 460 300 290 310 64 69 70 70

periods of time and at temperatures shown in Table 18. Results of tests on the aged samples indicate that aging is much less severe in the absence of oxygen. Considerable aging does take place, however, as is indicated by a 160% loss of elongation and a rise of more than 900 psi. in the 300% modulus for the compound (S77-DA) which was aged 96 hours at 212° F. It will be observed that the results of these tests in the absence of

TABLE 19. AIR OVEN AGING OF SULFUR AND NON-FREE SULFUR CURED NATURAL RUBBERS*

	No. and		I	Days @	212°	F.
Property Tested	Curing System	Orig.	3	7	14	21
Tensile, psi.	AllAl sulfur +					
	accelerator A1	2460	1340	340	250	brittle
	accelerators only AllAlC	2445	2210	1755	1630	565
	accelerators only A11A1C1	2235	1690	1090	505	120
	dicumyl peroxide	2520	1765	1155	735	not tested
% Elonga- tion	sulfur + accelerator accelerators	440	300	110	30	brittle
	only accelerators	610	570	510	480	370
	only dicumyl	430	380	360	350	290 not
Hardness.	peroxide sulfur +	310	290	. 240	330	tested
Shore A	accelerator	64	61	60	75	brittle
	only accelerators	54	54	54	54	51
	only dicumyl	59	58	52	49	47 not
	peroxide	63	60	55	48	tested

^{*}All compounds contain one part antioxidant.

oxygen (under vacuum) agree well with the previous results in which the oxygen was excluded by immersing

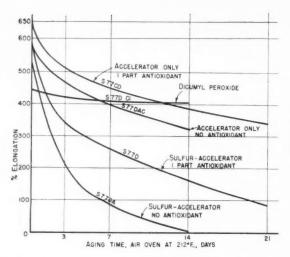


Fig. 5. Air oven aging of SBR as measured by % elongation changes for free sulfur, non-free sulfur, and dicumyl peroxide cured compounds

the specimens in boiling water at 212° F.

The above experiments and the results of long-term outdoor aging lead to the conclusion that oxygen is not an important factor in the aging of vulcanized rubber when the proper curing system has been used in preparing the vulcanizates. It is also shown that sulfur cured vulcanizates are especially sensitive to the presence of oxygen, even in minute quantities. In addition to being "oxygen sensitive" the sulfur-accelerator cured rubbers age considerably in the complete absence of oxygen. The accelerator cured rubber, on the other hand, has excellent resistance to aging whether oxygen is present or not.

Recent Developments

Having established that the type of curing system is the most important factor in aging of diene rubbers, the next logical step for Ordnance and other Department of Defense agencies, interested in the procurement of rubber having improved aging characteristics, is to require use of a curing system which contributes good aging to the rubber items purchased. Although the superior age resistance of non-free sulfur cured compounds has been long recognized, such compounds have not been used extensively (except in certain high-quality mechanical goods) for two principal reasons: (1) high cost of accelerators as compared with sulfur and (2) the poor processing safety of most non-free sulfur curing systems.

In view of the desirability of the non-free sulfur curing systems and in consideration of the chief objections to their use, a search has been made at this laboratory and at the University of Michigan under Ordnance contract (results of this contract will be published at a later date by the University of Michigan) for a non-free sulfur curing system having excellent age resistance, but being low in cost and having satisfactory processing safety. Of the 140 curing systems thus far examined in

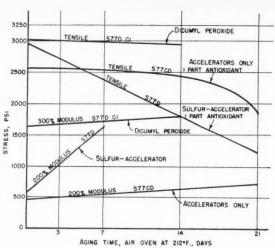


Fig. 6. Air oven aging as measured by tensile strength and moduli changes for SBR free sulfur, non-free sulfur, and dicumyl peroxide cured compounds

this laboratory, only a few showed age resistance equal to that of the thiuram/thiazole (Tetrone A/Captax) cure which was used as a control. None had a combination of good age resistance and good processing safety.

Dicumyl Peroxide Cures

Approximately two years ago the use of dicumyl peroxide (DCP) as a curative for the diene rubbers was described.¹³ The data which follow indicate that this curative may possess most of the features desired in a non-free sulfur curing system.

SBR COMPOUNDS. In Figure 5 the change in elongation after air oven aging up to 21 days at 212° F. for SBR using various curing systems (with and without antioxidant) is compared. When it is recalled that drop in elongation is one of the first results of aging in SBR, it will be immediately evident that the DCP cured SBR has suffered no aging by this criterion after 14 days in an air oven at 212° F.

A comparison of the tensile strength and moduli after oven aging of vulcanizates based on various curing systems is given in Figure 6. An examination of this graph indicates that the tensile and the modulus of the DCP cured SBR are practically unaffected after oven aging for 14 days at 212° F.

The % strain at 400 psi. load (NBS) for some of these compounds is furnished in Figure 7. A sharp drop in this property is generally indicative of marked aging. The DCP cured compound appears actually to have suffered a slight reversion in that the strain value has increased after oven aging for 14 days at 212° F. Such a result has never been experienced with any other curing system tested in SBR. These results have indicated that DCP cured SBR vulcanizates have excellent resistance to aging.

NR COMPOUNDS. A comparison of the oven aging re-

¹³ Hercules Powder Co., Wilmington, Del., new product data sheet No. 4-5-55.

Table 20. Air Oven Aging of Sulfur and Non-Free Sulfur Cured Nitrile Rubber

	Compound No. and Curing		Day	s (a 21	2° F.
Property Tested	System	Orig.	3	7	14
Tensile, psi.	N87 sulfur + accelerator N87C	2620	2950	3050	2845
	accelerators only N87C1 dicumyl	2010	2290	2190	2375
	peroxide	2030	2360	2180	2260
% Elongation	Sulfur + accelerator accelerators	370	290	250	210
	only dicumyl peroxide	430 300	400 300	320 250	310 260
Hardness, Shore A	Sulfur + accelerator accelerators	68	73	75	78
	only dicumyl	67	68	68	72
	peroxide	70	72	74	77
Strain @ 400 psi.	sulfur + accelerator accelerators	126	95	86	74
	only dicumvl	149	154	144	135
	peroxide	95	111	113	100

sults of DCP cured natural rubber with natural rubber cured using several other systems is provided in Table 19. A few conclusions which may be made from these data are:

1. DCP is a good curative for natural rubber, but not superior to certain accelerator cures.

2. Accelerated aging of natural rubber results in a sharp decrease in tensile strength just as in "natural" aging.

3. There is a great difference between the aging resistance of various accelerator cured rubbers.

4. By choice of the proper curing system one can obtain natural rubber vulcanizates which will resist oven aging up to 14 days at 212° F. without becoming severely degraded.

5. Natural rubber vulcanizates based on sulfur cures have extremely poor resistance to aging.

NITRILE RUBBER COMPOUNDS. Results of accelerated aging tests on nitrile rubbers cured with various systems are furnished in Table 20. In this case it will be observed again that the strain values indicate a slight reversion of the DCP cured nitrile rubber in the early stages of aging. Both the peroxide and the accelerator cured nitrile vulcanizates exhibited excellent resistance to aging up to 14 days at 212° F.

DCP COMPOUND PROCESSING. Having confirmed the excellent aging resistance of SBR, natural, and nitrile rubbers cured by DCP, an investigation of the processing

Table 21. Processing Safety of SBR* Containing DCP Curative

Treatment of Uncured Stock Prior to Cure†	Tensile,	300% Modu- lus, Psi.	% Elonga- tion	Hard- ness Shore A	Strain (a. 200 Psi.
Original	1975	1655	360	63	121
Conditioned					
1 hr. @					
212° F.	1925	1330	420	61	143
2 hrs. (a					
212° F.	1905	1150	450	60	154
24 hrs. (a					
212° F.	440	235	680	52	1
One Part DCP					-
added	2025	1940	310	66	70
Conditioned					
24 hrs. (a					
212° F.	1750		280	66	74

* 150 parts SBR 1104 plus one part DCP curative—RIA \$52C109DA compound.

S52C109DA compound. † All cures were for 30 minutes at 307 F.

‡ Beyond range.

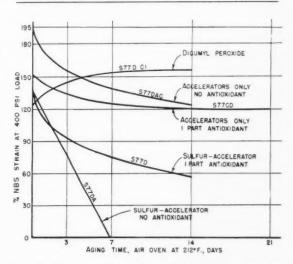


Fig. 7. Air oven aging as measured by NBS strain test for SBR free sulfur, non-free sulfur, and dicumyl peroxide cured compounds

safety of rubber compounds containing this material was undertaken.

The DCP compound Mooney scorch life had been reported to be comparable to that of sulfur-accelerator containing rubber compounds. It was observed however, that batches of uncured SBR containing DCP did not show the effects of scorch when placed on the mill even after exposure in an air oven at 212° F. for periods up to three weeks. These batches processed satisfactorily, but did not cure when attempts were made to mold them. It appeared that the peroxide had been decomposed in the rubber without, however, adversely affecting the rubber.

To ascertain whether the above-mentioned fact was true, a batch of SBR containing one part DCP as

TABLE 22. INCOMPATIBILITY OF DCP CURATIVE WITH ANTIOZONANT

			CP Cured SBR	DCP Cured Nitrile		
Property Tested	Control-Sulfur Cured SBR Plus 3 Parts Antiozonant S47A3B13	1 DCP S52C109DA No Antiozonant	1 DCP S52C109DAB 3 Parts Antiozonant	2 DCP S52C110DAB 3 Parts Antiozonant	1.5 DCP N94C1E No Antiozonant	1.5 DCP N94C1BE 3 Parts Antiozonant
Tensile, psi.	2240	1730	815	1755	1840	380
300 % Modulus, psi.	680	1260	270	765	1590	150
% Elongation	640	385	660	530	305	810
Hardness	60	55	45	48	56	39
Strain @ 400 psi.	82	114	250	133	100	> 400
Comp. set, 22 hrs. @ 158° F. Ozone resistance, loop spec-		8	34	12	8	69
imen, 25 pphm, time to first crack	O.K. 24 mos.	2 hrs.	12 days	2 hrs.	2 hrs.	2 hrs.
Outdoor, loop specimen, time to first crack	O.K. 24 mos.	1 day	6 wks.	5 wks.	1 day	1 day

TABLE 23. AIR OVEN AGING OF UNINHIBITED AND INHIBITED SBR PREPARED USING VARIOUS-TYPE CURES

Compound	S52C14	S52C14A	S77DAC Tetrone-	S77CD Tetrone-	S81DR Irradia-	S81DAR Irradia-	S77DA	S 77 D
	Peroxide No	Peroxide Plus	Captax No	Captax	tion No	tion Plus	Sulfur No	Sulfur
Physical Property	Inhibitor	Inhibitor	Inhibitor	Inhibitor	Inhibitor	Inhibitor	Inhibitor	Inhibitor
Original								
Tensile, psi.	2480	2470	2835	2610	2100	2390	3190	2950
Elongation, %	250	410	580	650	270	550	520	590
Hardness, Shore A	68	62	62	64	66	57	66	66
NBS @ 400 psi.	79	131	198	153	128	230	143	144
Air oven/70 hrs./212° F.								
Tensile, psi.	2280	2420	2870	2600	300	2380	2120	2610
Elongation, %	220	380	460	450	60	450	220	330
Hardness, Shore A	71	63	62	64	70	58	74	70
NBS, @ 400 psi.	77	126	155	134	all broke	184	75	88
Air oven/7 days/212° F.								
Tensile, psi.	brittle	2540	1920	2580		1610	815	2640
Elongation, %	brittle	400	400	460		400	80	270
Hardness, Shore A	91	65	65	66		64	82	74
NBS @ 400 psi.	brittle	119	150	126		168	all broke	80
Air oven/14 days/212° F.								
Tensile, psi.		1840	1960	2445				1950
Elongation, %		250	320	420				160
Hardness, Shore A		65	70	66				76
NBS @ 400 psi.		83	126	123				55

curative was exposed in an air oven at 212° F. for various periods of time, and pads were cured and tested after each period of exposure. Results of these tests are shown in Table 21. It may be readily seen from these results that the "scorch life" of the batch containing DCP is satisfactory after the batch was conditioned for two hours at 212° F. After 24 hours at 212° F., however, although still processing satisfactorily, the stock provides a "vulcanizate" which is definitely under-cured. Addition of one part DCP to this stock yielded a vulcanizate having properties essentially equal to the original properties.

It does appear, therefore, that the DCP curative can be decomposed, perhaps by reaction with moisture in the uncured batch, without adversely affecting the rubber with which it is in contact. It would seem that the Mooney scorch, which is based on an increase in viscosity caused primarily by reaction of the curatives with the uncured rubber, is not a satisfactory criterion for estimating the scorch-free life of uncured rubber containing DCP.

DCP PLUS ANTIOZONANT. In view of the excellent features of the DCP curing system an effort was made to combine these with the outstanding ozone resistance afforded SBR by the use of an antiozonant of the dioctylp-phenylene-diamine (UOP 88) type. Results of several attempts in this regard are presented in Table 22. These data indicate that use of an antiozonant, at the level required for good ozone resistance, seriously degrades the physical properties of the vulcanizate. In addition, the excellent ozone resistance expected of SBR containing the antiozonant is not obtained.

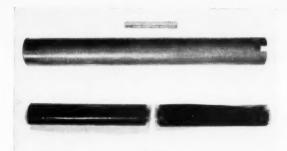


Fig. 8. Rubber samples wrapped in polyethlene, bottom, and aluminum canister used to contain samples, top, during irradiation with gamma rays

The degradation of physical properties, in this case, might be expected since the antiozonant is a mild reducing agent while the DCP is an oxidizing agent. When intimately mixed in the rubber batch and subjected to vulcanizing temperatures, these ingredients react to destroy each other. If a higher concentration of DCP is used (S52C110DAB), a good cure can be obtained since the DCP remaining after destruction of the antiozonant is still sufficient to provide a full cure. Destruction of the antiozonant may be inferred from the poor ozone resistance of this vulcanizate. Such compounds can be protected (from ozone cracking) after cure by the external application of an antiozonant-solvent paint.

In contrast to this incompatibility of DCP curative with amine-type antiozonant, the data in Table 23 show that an amine antioxidant (PBNA) is required to provide good age resistance to vulcanizates based on peroxide cure.

The value of using an inhibitor in sulfur-accelerator cured and radiation cured rubbers is also demonstrated by the data in this table. Only the thiuram/thiazole (Tetrone A/Captax) accelerator cured vulcanizate has excellent aging resistance *both* with and without antioxidant.

The irradiation cured samples were obtained by rolling uncured sheets between a polyethylene liner, inserting into an aluminum canister (Figure 8), placing the canister into a Cobalt 60 source (Figure 9), and subjecting the samples to 30 megareps of gamma radiation.

Summary and Conclusions

It has been shown that aging in the diene rubbers is intimately connected with the curing system used in the preparation of these rubbers. By proper choice of curing system one can obtain vulcanizates which are inherently resistant to aging in the presence or absence of oxygen.

Aging tests conducted on sulfur-accelerator cured SBR both in the presence and the absence of oxygen have indicated that the aging of SBR vulcanizates (sulfur-accelerator cured) is caused by two principal factors, viz., an extreme sensitivity to oxygen and degradation due to internal reactions in the rubber which occur in the complete absence of oxygen.

The value of using simple tests involving the reaction



Fig. 9. Cobalt 60 source showing remote control loading device

of gaseous oxygen with vulcanized rubber (oxygen absorption) for investigating the aging of vulcanized rubber is questionable for the following reasons:

1. Aging has been shown to be dependent upon the curing system, and, therefore, such a method has at best only a very limited applicability.

2. Aging occurs even in the complete absence of oxygen.

3. Certain vulcanizates are not "aged" by oxygen.

4. Correlation of oxygen-type aging with physical property deterioration is lacking.

The individual effects of chemical reaction with gaseous oxygen ("oxidation") and the purely thermal effects (after vulcanization) cannot be distinguished.

It is the opinion of the authors that the use of non-free sulfur curing systems used in conjunction with suitable antiozonants and antioxidants represents the best means for Department of Defense agencies to obtain rubber end-items possessing the inherent ability to perform their necessary function after prolonged storage in the field and in warehouses.

The authors wish to express their appreciation to the Ordnance Corps, United States Army, and to the supervisory staff of the Rock Island Arsenal for permission to publish the information given in this paper.

British Research Spending High

Great Britain is spending 2% of its gross national product on research and development, a figure greater than in the United States, which is currently spending about 1.5%. During 1955, the British spent \$930,000,000 for research and development, of which private industry accounted for about \$518,000,000. About two-thirds of this expenditure was devoted to defense purposes.

MEETINGS and REPORTS

Rubber Division ACS, CIC, Montreal Conference; Colwyn Medal Award; Reception by City Planned

The 1957 Joint Conference of the Divisions of Rubber Chemistry of the American Chemical Society and the Chemical Institute of Canada to be held in Montreal, P.Q., Canada, May 15 through 17, will be featured by presentation of the Colwyn Medal for 1956 of the Institution of the Rubber Industry, of London, England, to W. B. Wiegand, director and research consultant for Columbian Carbon Co., and a reception for all registrants by the City of Montreal at the Chalet on top of Mount Royal. The headquarters hotel will be the Sheraton-Mount Royal.

There will be four technical sessions, the first of which will begin at 2:00 p.m., Wednesday, May 15, with B. S. Garvey, Jr., industrial division, Pennsylvania Salt Mfg. Co., chairman of the ACS Rubber Division, presiding. The papers to be presented at this first session deal mostly with testing procedures. O. R. Huggenberger, Dominion Rubber Co., Ltd., chairman of the local arrangements committee, will preside at the second session, on Thursday morning, and most of the papers at this session will be devoted to carbon black. The business meetings of the two Rubber Divisions will be held as part of this session, and it will be concluded with the Colwyn Medal Address by Dr. Wiegand on "Carbon Black."

J. D. D'Ianni, Goodyear Tire & Rubber Co., director-at-large, Rubber Division, ACS, will preside at the third session, on Thursday afternoon. The papers at this session will be concerned mostly with compounding and processing. The fourth and final session on Friday morning will have N. S. Grace, Dunlop Canada, Ltd., and director from Canada of the Rubber Division, ACS, as presiding officer, The papers at this last session will be devoted to new polymers.

For the benefit of early arrivals, there will be an opportunity to register from 4:00 to 9:00 p.m., Tuesday, May 14, on the ninth floor of the Sheraton-Mount Royal Hotel, as well as on the remaining days of the meeting.

The 25-Year Club of the ACS Rubber Division will hold its luncheon meeting at 12:30 p.m., Wednesday, May 15, preceded by a get-together session starting at 11:30 a.m. Dr. Grace will be chairman for this Montreal meeting of the 25-Year Club.

The reception for registrants to be given by the City of Montreal at the Chalet on top of Mount Royal is scheduled for Wednesday evening, May 15, and bus service will be provided from the door of the headquarters hotel.

The banquet, scheduled for Thursday evening, May 16, will be highlighted by the presentation of the Colwyn Medal for 1956 to Dr. Wiegand. G. S. Whitby, University of Akron, will make the presentation and talk briefly regarding the Medalist and his accomplishments. The dinner will feature a fine French cuisine, and the evening will be concluded with a top-notch floor show.

There will be a special program for the ladies, and they will be asked to register. A nominal fee will be charged to help defray the expenses of the various activities which include a get-acquainted luncheon on Wednesday, to be followed by a tour of the city in the afternoon. There will be a trip to the picturesque Laurentian Mountains on Thursday, with lunch at the famous Mount Gabriel Club.

The chairman of the local committee on arrangements is Mr. Huggenberger, and J. L. MacDonald, Du Pont of Canada, Ltd., is co-chairman and secretary. Other members of the local committee and their responsibilities follow: Q. R. Ball, Northern Electric Co., Ltd., banquet; H. Hencher, H. L. Blachford, Ltd., finances; E. B. Bibby, Harrisons & Crosfield (Can.), Ltd., housing; A. W. Bell, St. Lawrence Chemical Co., Ltd., ladies program; E. A. MacKenzie, Pirelli Cables, Conduits, Ltd., program and meeting rooms; A. B. Lewis, British Rubber Co., Ltd., publicity; W. R. Blundell, Dominion Rubber, registration; and W. Edwar, Caledonia Co., Ltd., special events.

Program and Abstracts of Papers

Wednesday Morning, May 15

9:00 a.m. Registration. 11:30 a.m. 25-Year Club Luncheon-Meeting. N. S. Grace, chairman.

> Wednesday Afternoon-May 15 **Testing Procedures**

> > B. S. Garvey, Presiding

2:00 p.m.—1. Introductory remarks. B. S. Garvey, Jr.

2:10 p.m.-2. The Application of Near-Infrared Spectroscopy to the Analysis of

¹Name in bold face type indicates person presenting paper.

2Beckman Instruments, Inc., South Pasa-

dena, Calif.

Polymeric Materials-I. The Identification of Polymers and Polymer Mixtures. M. J. Brock1 and George D. Louth, Firestone Tire & Rubber Co., Akron 17, O.

The development of the Beckman DK-2 spectrophotometer2 has made the nearinfrared range more accessible to investigation. Previous researches have shown that the 750-3,500-millimicron region is rich in absorption due to CH, NH, and OH stretching vibrations.

The near-infrared absorption characteristics of pyrolyzed polymers and polymer products show that this technique has utility in the identification of polymers and polymer mixtures. The method consists of using a gas burner to pyrolyze rapidly the sample in a side-arm test tube, collecting the distillate, diluting with carbon tetrachloride, filtering, and obtaining the absorption spectra from 1,000 to 3,200 millimicrons. The preparation of the distillate is reproducible. It removes the polymeric components from any non-volatile loading material present and permits the rapid examination of vulcanized or cross-linked insoluble products as well as raw polymers.

The polymers are identified by characteristic absorption maxima or by comparison with absorption curves of known ma-

A variety of elastomers and plastomers has been studied. Application to the identification of mixtures is exemplified by the detection of the presence of SBR (styrene/ butadiene rubber) in vulcanized mixtures of SBR and natural rubber. This is possible because the aromatic CH absorption due to the styrene in SBR is characteristically different from the aliphatic CH absorptions of natural rubber.

2:30 p.m.-3. The Application of Near-Infrared Spectroscopy to the Analysis of Polymeric Materials—II. The Quantitative Absorptiometric Determination of Elastomers in Rubber Products. K. E. Kress, Firestone

A Beckman DK-2 recording spectrophotometer is applied to quantitative absorptiometric analysis of elastomer pyrolyzates in the near-infrared spectral region from 2,100 to 3,200mµ. This versatile method has been proved rapid and reliable for analysis of the common general-purpose elastomers when used alone or as mixtures.

About 200 to 300 milligrams of the extracted rubber product are pyrolyzed over a gas flame, and the distillate is retained in on

3.0 milliliters of perchloroethylene. Nearinfrared absorbance is recorded in one centimeter quartz cells.

Quantitative analysis of mixed natural and styrene-butadiene rubber (SBR), or natural and butyl rubbers, is achieved in about 15 minutes by an absorbance ratio method with an accuracy comparable to that of the single-purpose chromic acid method for determining natural rubber. Ready application to analysis of other elastomer mixtures and also to plastomers is evident.

This analysis is not affected by normal variation in styrene content of SBR, but use of an absorbance ratio at different wave lengths makes possible direct determination of the styrene present in the copolymer. The acrylonitrile content of nitrile rubbers may be determined in a similar manner.

A direct absorptiometric analysis for % total polymer as synthetic SBR or butyl rubber replaces the present indirect analysis by difference.

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2:50 p.m.—4. The Dunlop Rotary Resilience Machine. D. Bulgin, G. D. Hubbard, Dunlop Research Center, Birmingham, England. Presented by A. D. Duigle, Dunlop Research Center, Toronto, Ont., Canada.

A machine for measuring dynamic modulus and resilience is described, which has been found to be of particular value in the design of compounds for use in tires.

In principle this machine consists of an annular solid sample on a suitable steel center which revolves under load on a drum driven at a constant speed. The sample can be cooled or heated so that the dynamic modulus, energy loss, and resilience can be determined continuously from -80 to $+200^{\circ}$ C.

The sample undergoes deflection similar to that of a tire, i.e., a cycle of deflection and relaxation followed by a comparatively long rest period between successive cycles. Two speeds equivalent to road speeds of about 30 and 120 m.p.h. can be used.

The relations of deflection to modulus and of the energy stored in the deflected sample to deflection and applied load have been calculated. The dynamic and static modulus and the resilience of the sample defined as energy returned/energy input per deflection cycle can be calculated. Experiment shows these calculations to be accurate within acceptable limits.

The machine enables routine laboratory measurements to be made of dynamic modulus, energy loss under standard load or standard deflection conditions, and resilience as a continuous function with temperature.

The time required for test from room temperature to 200° C. is approximately one hour.

3:20 p.m.—5. Temperature Effects on Elastomer Flow Patterns in the Mooney Viscometer. David Craig, A. E. Juve, L. O. Schroyer, C. E. Sitz, R. A. Harrington, Ross Shearer, B. F. Goodrich Co., Brecksville O.

A straight-line relation was expected between reciprocal absolute temperature and log of the Mooney viscosity for rubbers such as the former GR-I 18.3 The actual plots, however, in each case followed more



Willard Stewart, Inc.

B. S. Garvey, Jr.

than one line. The complicated nature of flow in the viscometer was revealed by studying specimens made up of alternate black and white layers. These specimens were sliced after running, and the type and the extent of flow noted by visual inspection.

The nature of the flow can be understood to some extent by study of these specimens along with results reported by Mooney and Wolstenholme and also those by Fensom for differently constructed specimens. The increase in Mooney viscosity during measurement, which results for some rubbers and which has been called the Y value by other investigators, has been found to result from "make-up" of the specimen following the slight breakdown during the initial period of running.

3:45 p.m.—6. An Electronically Instrumented Pendulum for Evaluating Impact Absorption of Foam Materials, C. S. Wilkinson, Jr., Goodyear, Akron.

The impact pendulum, a familiar and convenient apparatus in rubber technology, has been adapted for use in the evaluation of foam materials for shock and vibration absorption applications, including crash pads of various types. Appropriate pendulum design and electronic instrumentation provide an advantageous system for measuring their impact characteristics. In order to obtain the maximum information from the data it is necessary also to have an understanding of the physics involved.

The mechanical and electrical features of a machine suitable for making the necessary measurements are described. Mathematical formulae and computations required for designing the pendulum and analyzing the data are indicated.

An explanation of the method of obtaining data is given, and a representative complete analysis of the results for a foam sample is presented as an example. Typical results from a few different kinds of foam are included as illustrations of the method and the performance of the equipment.

Such characteristics as energy absorption, peak deceleration, duration of maxi-

³Isoprene-isobutylene rubber (IIR) such as Enjay Butyl 218.

mum deceleration, and rate of deceleration must be considered in the development of suitable foams. The machine described is a useful device in the laboratory evaluation of these properties.

4:10 p.m.—7. A Constant Torque Abrader with a Permanent Abrasive Surface. Ira Williams, J. M. Huber Corp., Borger, Tex.

The Grasselli Du Pont abrader has been modified to provide variable speed and to operate at any predetermined constant rate of work. The round test disks are rotated flat against the abrasive surface at the same r.p.m. as the abrasive disk. This practice assures a uniform rate of wear on the entire surface and provides an abrasive action in every direction. The test pieces and the abrasive disk are enclosed in a cabinet which may be heated.

The abrasive surface is a metal disk with 30 mesh carborundum grit sparsely bonded with a modified epoxy resin. Such disks are easily duplicated within ±2% and have maintained unchanged cutting power on tread stocks for six million revolutions. Such a disk becomes a standard for the measurement of abrasion. A constant talc feed effectively protects the abrasive from becoming smeared by any type of compound, and the cutting rate remains unchanged regardless of the type of compound previously tested.

While the machine is capable of reproducing results within 2% or 3%, it will not predict the service life of a compound. It appears to predict reliably the relative performance of compounds using the same basic matrix. This machine is useful in studying the effect of such factors as amounts and types of pigmentation or the effect of chemicals or temperature of operation or rate of slip within one basic matrix. No abrasion machine will compare compounds such as SBR, oil-extended SBR, or butyl rubber based on a widely different matrix, but may compare compounds based on such similar elastomers as natural and SBR rubbers provided the other substances in the matrix are the same.

Thursday Morning—May 16 Carbon Black

O. R. Huggenberger, Presiding

9:00 a.m.—8. Lignin as a Reinforcement for SBR in Military Pattern Tires. Lloyd Krichew, Department of National Defense, Ottawa, Ont., Canada; D. W. MacGregor, Howard Smith Paper Mills, Cornwall, Ont.; T. R. Griffith, National Research Council, Ottawa.

The Department of National Defense has a continuing interest in the existence and utilization of substitute materials, to insure wartime availability. Lignin's potential as a reinforcement for rubber compounds has been known for some time. Published and unpublished data indicated that sulfate lignin might be a useful reinforcement material for high-synthetic-rubber-content military pattern tires.

A cooperative program involving Canadian industry and government agencies was initiated to determine the feasibility of using lignin in this application.

This paper reports the work done in pro-

ducing a quantity of experimental 11.00 x 20. 12PR, non-directional cross-country military tires, having a SBR-lignin tread, with the current carcass construction, using conventional processing equipment; it compares results of these tires with carbon black controls, when performance tested on the indoor endurance wheel and when road service tested in Texas, by Three-T-Fleet. Inc., under controlled conditions.

Laboratory data show comparable results, with road-service tests demonstrating improved tread wear performance and hysteresis properties. Results of highway, gravel, and cross-country operation will be shown. The tread stock formulation, showing the lignin loading and the curing system used will also be given.

9:25 a.m.-9. A Study of the Moisture Adsorption Properties of Carbon Blacks. Eli M. Dannenberg, Webster H. Opie, Jr., Godfrey L. Cabot. Inc., Boston, Mass.

The moisture adsorption properties of commercial carbon blacks are of direct practical interest in many product applications. In color pigment applications controlled moisture content is actually beneficial, helping to contribute to improved flow characteristics. The curing rates of rubber compounds can either be accelerated or reduced by the presence of moisture, depending upon the curing systems being used. Excessive moisture in carbon black loaded polyethylene stocks can give rise to bubbling during extrusion. From a more fundamental and scientific point of view, studies of the adsorption of polar water molecules on carbon black are useful in elucidating the varied nature of carbon black surfaces.

Moisture adsorption measurements at various relative humidities were made on a complete range of commercial rubber and ink grades of carbon blacks. A series of heat treated MPC blacks was also studied.

A number of conclusions can be made based on the data obtained. The rates of moisture adsorption for channel blacks are faster than for furnace blacks. Moisture adsorption in the lower humidity range is dependent more on volatile content than on specific surface area. In the high humidity range adsorption depends on surface area. Equilibrium moisture adsorption data at a low and at a high humidity can be used as an approximate method for determining both the volatile content and the surface area of channel grade carbon blacks. At humidities greater than 90%. moisture adsorption is sharply affected by bulk density, indicating the occurrence of interparticle capillary condensation.

The high-temperature treatment of carbon black causes marked changes in moisture adsorption capacity, particularly in the temperature range where hydrogen evolution occurs.

The ash content of furnace grade carbons is shown to have some influence on moisture adsorption in the high humidity range. At a humidity of 50% where ash content has an insignificant effect, it is possible to show a good correlation between moisture adsorption and surface area for the furnace-grade carbons.

It is shown that a masterbatch of carbon black and rubber will adsorb moisture at a very low rate in quantities related to the



O. R. Huggenberger

particle size and the type of carbon black. The fact that the carbon black surface in rubber is still almost totally active in its ability to adsorb polar molecules has some interesting fundamental implications regarding the nature of the rubber-carbon black interface.

9:55 a.m.-10. Infrared Studies of the Chemical Constitution of Carbon Black Surfaces. Harvey M. Cole, Eli M. Dannenberg, Godfrey L. Cabot, Inc.

The applicability of infrared spectrographic methods for determining the chemical constitution of carbon black surfaces was investigated. The high selectivity of infrared absorption data for detecting organic functional groups appeared promising provided the usual experimental techniques could be modified to reduce sufficiently the interference of the intense background absorption of the carbon black substrate. This modification was successfully accomplished by the insertion of fine metallic screens into the reference beam of a double-beam spectrophotometer, resulting in an improved instrumental response to the selective absorptions of the carbon black surface complexes.

It was found that these techniques result in reasonably strong spectral bands when applied to the highly oxidized blacks, highly treated ozonized and nitric-acid blacks; while weaker, less useful spectra were found for the less rigorously treated blacks. The furnace-grade carbon blacks investigated, Vulcans⁴ 3, 6, 9, SC, and Sterling SO4, gave weak absorption bands of negligible informative value. Consequently most of the work reported here involves blacks containing appreciable "volatile" or oxygen

The experimental approach followed was one of alternating chemical treatment and infrared examination. Many chemical reagents were employed, including oxidizing and reducing agents, peroxides, and various chemical materials known to be reactive with specific organic functional groups.

4Godfrey L. Cabot, Inc., trade mark. ⁵Present address—Graduate School, Princeton University, Princeton, N. J.

Strong evidence was obtained for the presence of hydroxyl, carboxyl, aldehyde and/or ketone groups plus a small quantity of molecular carbon dioxide. Chelated carbonyl was indicated; while little or no evidence was found for assuming the presence of quinone-like surface structures. Also, postulation of the occurrence of many of these functional groups on adjacent carbon atoms is entirely compatible with both the infrared data and the observed effects of chemical treatment.

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It is suggested that study of the reactivity of these highly oxygenated blacks is of value not only with respect to the particular black studied, but also because such study may be indicative of an analogous behavior in the case of other less easily studied carbon blacks.

10:25 a.m.-11. Improving the Carbon-Rubber Bond. H. A. Braendle, Columbian Carbon Co., New York, N. Y.

Colloidal carbon (or carbon black) is recognized as the most powerful industrial colloid. Rubber is an equally versatile colloid whether produced by nature in a tropical climate or made by man in a reaction kettle. The affinity of these two colloids for each other makes possible the speed, economy, and safety of automotive transport.

The scientist in his laboratory and the compounder in his factory both recognize the need of optimum spacial distribution of carbon black in rubber. In the factory at least, the trend has been to apply more and more force to push the two together. Today we've reached the point where it may well be that damage to both colloids may outweigh the advantage of dispersion attained by force alone.

Research for new and better carbons indicates that today's mixing techniques fall short of utilizing the full potential reinforcement of the commercial carbons now in general use.

A new concept was needed-the proper timing of the union of these two colloids. Industry has used the shotgun-wedding approach. Our continuous black-rubber process brings them together at an optimum time and in an optimum environment where their natural affinity can produce a stronger and more lasting bond. The evidence-markedly better road wear.

10:50 a.m. Business Meeting, Division of Rubber Chemistry, ACS, Division of Rubber Chemistry, CIC.

11.15 a.m.-12. Carbon Black. W. B. Wiegand, Columbian Carbon Co. Colwyn Medal Address of Institution of the Rubber

> Thursday Afternoon-May 16 Compounding and Processing J. D. D'Ianni, Presiding

2:00 p.m.-13. The Thermal Diffusivity of Butyl Rubber and Its Compounds. Donald R. MacRae⁵ and R. L. Zapp, Enjay Laboratories, Linden, N. J.

Thermal diffusivity is the rate at which a temperature gradient travels through a mass of material. It is related to thermal conductivity by the expression K=W/pc, men distr 2:

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where W is the coefficient of thermal conductivity, p is the density, and c the specific heat. The determination of coefficients was based on the work of Williamson and Adams. The actual experiments were variations of the method of Rehner using thermocouples embedded in the center of spherical rubber specimens. The thermal diffusivity coefficient, K, varies lineally with temperature, with K decreasing as temperature is raised. Therefore, for a mass of rubber being heated, the coefficient must be expressed at an average temperature.

For butyl rubber compounds the following generalizations may be made:

1. The diffusivity coefficients for butyl range from 0.67 x 10⁻³ cm²/sec. for a gum vulcanizate to 2.31 x 10⁻³ cm²/sec. for 160 parts of an HMF black in 100 parts of polymer. These are given for an average temperature of 210° F.

2. Thermal diffusivity is not dependent upon the state of cure of the butyl vulcanizate. Coefficients are similar at a high and a low concentration of sulfur cross-

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3. The higher the loading of carbon black the higher will be the diffusivity coefficient and the greater will be the temperature sensitivity. The contribution of carbon black is more dependent on volume loading than on carbon black type.

4. A ground whiting (CaCO₃) as a filler yields compounds with lower diffusivity coefficients on an equal volume basis. This may be a function of lower pigment poly-

The application of thermal diffusivity coefficients to the heating of large slabs is demonstrated.

2:30 p.m.—14. Details on the Half Life of Polymeric Free Radicals. G. Goldfinger et al., Armour Research Foundation, Chicago, Ill., and the University of Buffalo, Buffalo, N. Y.

A model is presented, based on the experimental conditions prevailing during photopolymerization in a free falling stream.⁶ Applying some simplifying assumptions, it is possible to correlate quantities potentially measurable, such as yield of reaction and number and weight average molecular weights with the spread of times elapsing between subsequent addition steps. In other words, the average time elapsed can be refined to a time distribution curve.

In the model, the time elapsed between initiation and forcible termination is subdivided into t time elements. During each of those it is assumed that exactly one of the following must occur: the growth of the free radical to one larger by one monomer unit, natural termination without any change of size, or nothing. The sum of the probabilities of those events, called, respectively, S, f, and i, is, of course, exactly 1. Considering forcible termination of all polyradicals still surviving after t time elements, one can calculate size and weight distribution curves.

2:55 p.m.—15. The Dependence of Tack Strength on Molecular Properties. W. G. Forbes and L. A. McLeod, Polymer Corp., Ltd., Sarnia, Ont.

A method has been developed for measurement of the tack strength of fresh, reproducibly smooth rubber surfaces. Using

this method, the tack strength of natural rubber is shown to be independent of polymer purity, Mooney, intrinsic viscosity, gel content, and molecular weight distribution.

Variations have been observed in the tack strengths of synthetic elastomers and in the potential tack strength as represented by the green tensile strength. The ratio of these two properties (called "relative tack") is found to vary with the shear viscosity of the polymer and can be altered significantly by changes in catalyst system or polymerization temperature. The lower the value of "relative tack" the longer the contact time required to increase it toward its limiting value of 1.

Measurements of copolymers of butadiene and styrene prepared in the Alfin system and in emulsion, butyl polymers, butadiene-acrylonitrile copolymers, and polyisoprene prepared in different ways indicate the importance of shear viscosity in determining relative tack strength. These measurements also indicate that relative tack is influenced much more by polymer molecular weight and chain entanglements than by microstructure.

The bond strength between two different uncured polymers is shown to depend on the difference between their cohesive energy densities. Laboratory measurements have been made on industrially compounded samples and found to give ratings consistent with factory experience.

3:20 p.m.—16. Electronically Sorted Punched Cards for Polymer Compounding Data. R. F. Neu, Enjay Laboratories.

Greatly increased research activity in the now competitive synthetic rubber industry is leading to the accumulation of great masses of useful information. A problem which must be faced at all levels of polymer research work—basic, applied, and technical service—is that of recording this information in such a manner that it maintains its value by being readily available for future reference.

This paper describes the compact, efficient, and flexible punched-card technical data filing system now in use at Enjay Laboratories. Suggestions for the organization

⁶G. Goldfinger, C. Heffelfinger, J. Polymer Sci., 13, 123 (1954).



James D. D'lanni

of such a data processing system are presented along with recommendations for design of card forms and data report forms. The characteristics and attributes of a relatively new electronic statistical machine are discussed. This machine seems ideally suited to the handling of this type of data. The flexibility of the system is indicated by specific examples of problems which have been dealt with by it—problems in file searching; rearrangement of large masses of data into a given order; frequency distribution and correlation analyses; and statistical calculations.

This data processing system is offered as one technique by which other polymer laboratories may profit in utilizing manpower to the fullest.

3:45 p.m.—17. The Coding of Rubber Properties into a Specification. Glenn E. King, Yale Rubber Mfg. Co., Sandusky, Mich.

A coding system has been developed that consists of a prefix letter, a Roman numeral to indicate the hardness test instrument and a series of Arabic numbers to indicate hardness, tensile, and elongation. Basic test requirements are associated with the coding when a suffix is not used. A second level of test severity is specified when suffix letters are used.

Suffix letters indicate a class of tests rather than an individual test. The classification of the tests are based on similar properties. Individual test methods are indicated by small letters in a subscript. Tensile, elongation, and hardness changes associated with the test are indicated by a number in front of the method letter. Volume is indicated by a number following the letter in the subscript. The time and temperature variables are coded into a superscript.

The system is unique in the method of application of subscripts and superscripts and in the method of coding the temperature. Problems of definition and control of a coding system are discussed.

4:10 p.m.—18. Resorcinol-Formaldehyde Latex Adhesive for Bonding Synthetic Tire Cords, M. I. Dietrick, Koppers Co., Pittsburgh, Pa.

The adhesion of tire cords to the adjacent rubber in the carcass of the tire has developed from a minor problem with the cotton reinforced tire of the '30s, where high speed operation was minimal, to a major problem with the rayon and nylon reinforced tires, and the increasingly higher operating speeds of today. The resorcinol-formaldehyde-latex (RFL) adhesive has found wide usage for bonding rayon and nylon cords in the carcass of the tire; however, little work has been published on the dip composition as related to adhesion.

This paper deals with the study of formulation variables that affect the adhesion of resorcinol-formaldehyde-latex compositions used to bond rayon and nylon tire cords to natural rubber. The treating and testing methods are described. Variables studied include; in situ resinification as compared with preformed resin; the resorcinol or resorcinol resin concentration; the formaldehyde concentration; the pH as adjusted with sodium hydroxide and/or ammonium hydroxide; dip concentration; and composition of the latex.

These studies show that bonds approaching the strength of the rubber stock are obtainable with properly compounded RFL adhesives.

4:40 p.m.—**19.** Radiation Effects in Elastomeric Vulcanizates. B. L. Johnson, H. E. Adams, Marie Barzan, Firestone.

As the application of atomic energy to civilian and military purposes becomes more common, a knowledge of the effect of nuclear radiations on polymers becomes more important. Therefore the effects of gamma radiation on the physical properties of tread-type vulcanizates have been evaluated by standard test methods over a temperature range of from 73 to 500° F.

Natural rubber is indicated to be best for usage as a general-purpose elastomer in compounds to be exposed to gamma radiation. This is especially true for products which must withstand flexure. Irradiated, natural rubber vulcanizates containing carbon black are superior to the non-irradiated vulcanizates in tensile strength at 400 to 500° F. At lower test temperatures, however, tensile strength is not equal to that of the non-irradiated vulcanizates. This phenomenon is believed to be due to a high level of radiation induced cross-linking which may reduce crystallinity at the lower test temperature and, at the same time, be responsible for the improved strength at the higher temperatures.

These data indicate that the cross-linking of natural rubber compounds by nuclear radiation may prove of value in the development of heat resistant, elastomeric products having good flexing characteristics.

7:30 p.m.—Banquet. Colwyn Medal Presentation. "Weigand—The Man." G. S. Whitby, University of Akron.

Friday Morning—May 17 New Polymers

N. S. Grace, Presiding

9:00 a.m.—20. Vulcanizable Saturated Acrylate Elastomers. Fred Leonard, Joshua Nelson, George Brandes, Walter Reed Army Medical Center, Washington, D. C.

In the course of an investigation of latex dispersed elastomers suitable for use in cosmetic gloves for amputees, terpolymers of butyl acrylate methylmethacrylate and methacrylamide have been studied.

The redox emulsion polymerization rates for the preparation of the terpolymers in the presence of sulfuric acid (ph 2.5) and sodium hydroxide (pH 8.5-11.4) were approximately 11% per hour; whereas the rates in the presence of ammonium hydroxide (pH 10) were 30% per hour. An explanation for this apparent anomaly is given.

The terpolymers were vulcanizable with formaldehyde, and the mechanism for the vulcanization reaction is elucidated.

Stress-strain curves, as a function of cross-linking, were shown to be dependent upon rate of strain. At 20 inches per minute the stress-strain curves were relatively insensitive to cross-linking concentration; whereas at 0.2-inch per minute the stress-strain curves approached closer to the stress ordinate in a predictable manner as the concentration of cross-links



Ashley & Crippen

Norman S. Grace

was increased. Cyclic tensile fatigue data, swelling index, and solubility varied in a consistent manner with increasing cross-linking.

Post-dipping cast films in methyl formal, followed by heat curing, resulted in the enhancement of surface properties, such as solvent, stain, and abrasion resistance. This treatment also resulted in increased resistance to cyclic tensile fatigue, and a shift of the stress-strain curves of the materials so treated toward the stress axis. Post-treatment effects were greater on initially uncross-linked and lightly cross-linked films. Highly cross-linked rubbery films were relatively insensitive to this treatment.

9:25 a.m.—21. Cure of Polyurethane Elastomers with Peroxides. E. E. Gruber, O. C. Keplinger, General Tire & Rubber Co., Akron.

The practice of curing polyurethane elastomers through reactions of residual isocyanate groups is attended by certain unfavorable processing characteristics which have been a deterrent to their commercialization. Scorch, short storage life, excessive toughness, and complex molding cycles have heretofore been common experiences. Further, despite some unusual properties, polyurethanes cured with excess isocyanate have not shown good dynamic properties. This condition is shown by their lack of balance between flex cracking and heat build-up. Their poor stability, as measured by tensile creep, is perhaps another reflection of the inadequacy of this curing system.

It has been found that when peroxides are used in place of excess isocyanate for curing the polyurethane, these principal disadvantages can be overcome. Use of the peroxide cure permits ease of milling, scorch-free processing, and stable storage of fully compounded stocks. The cured product exhibits a good balance of dynamic properties, and stress-stability is much improved.

The peroxide cure of polyurethanes has been studied over wide ranges of peroxide structures and pigmentation. Dicumyl peroxide seems the best choice for curing polyurethane gum, black loaded or pig-

mentea stocks. Use of 2.5-3.0 parts of dicumyl peroxide appears to be optimum for poly(ethylene propylene) adipate 0.97 methylene di(p-phenylene dissocyanate) polyurethane which can advantageously be loaded with 20-30 parts of MAF black.

9:50 a.m.—22. The Cross-Linking of Butadiene-Acrylate Elastomers by Bases. W. Cooper, T. B. Bird. Dunlop Research Center, Birmingham. Presented by R. T. Woodhams, Dunlop Research Center, Toronto.

It is well-known that high-strength elastomers are obtained by cross-linking copolymers of butadiene containing free carboxylic acid groupings with metal oxides. Vulcanizates of high strength (tensile strength 4000-5500 lbs/sq.in., elongation at break 450-700%, 300% modulus 1200-2000 lbs/sq.in., tear strength up to 400 lbs/in.) have now been obtained from copolymers of butadiene and acrylic esters, since it has been found that the normally slow cures effected by alkaline earth hydroxides are greatly accelerated by glycols and other polyhydroxy compounds.

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Copolymers of butadiene with methyl and ethyl acrylates have been mainly studied; the minimum proportions of acrylate for good vulcanizates are 20 and 25%, respectively. Elastomers of butadiene, acrylate and acrylonitrile have also been studied. Partial or complete replacement of the alkyl acrylate by a small proportion (5-10%) of 2-cyanoethylacrylate gives elastomers which cure very rapidly, using the glycol-calcium hydroxide system.

These polymers are more easily made than those in which free acid groups are introduced into the polymer, and they are also free from the tendency to scorch during processing.

The most powerful curing effects are observed with those polyhydroxy compounds which are good solvents for the bases, but those in which they are but slightly soluble still produce an acceleration in the rate of cure. The effect of the glycols in transporting moisture into the polymer is not thought to be of great consequence, and there is no evidence that they form cross-links directly by a base-catalyzed ester interchange reaction.

10:15 a.m.—23. Control of Degradation in Oil-Extended Styrene-Butadiene Rubber. R. J. Reynolds, Shell Development Co., Emeryville, Calif.

Extensive studies in the recent literature have shown that extending oils promote the oxidative degradation of raw styrene-butadiene rubber in the presence of transition metal ions. Degradation has been effectively retarded by use of low iron polymerization recipes for the base polymer. Unfortunately, methods found for stabilizing oil-masterbatch based on conventional iron-pyrophosphate recipes have generally been inadequate and dependent on rather costly additives.

The present work demonstrates that degradation of conventional iron-containing oil-masterbatch can be satisfactorily inhibited by small quantities of inexpensive magnesium compounds. The most efficient results were obtained by simply adding magnesium naphthenates or resinates to the extending oil prior to emulsification and co-coagulation of the latex-

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oil blend. Alternatively, magnesium sulfate could be added to the coagulating acid. Magnesium levels of 125-500 parts per million of oil-extended rubber generally imparted heat aging stability equivalent to that of the oil-free base polymer. Magnesium naphthenates or resinates caused a slight retardation of cure, but had little or no apparent effect either on processability or vulcanizate quality at optimum cure.

A free-radical chain mechanism is presented which reasonably accounts for the degradation of raw rubber caused by extending oils and iron salts. Magnesium compounds are postulated to interfere with this chain mechanism by blocking a homogeneous catalytic effect by iron.

10:40 a.m.—24. Recent Developments in the Application of Kel-F⁷ Elastomer. Lester E. Robb, Francis J. Honn, David R. Wolf, M. W. Kellogg Co., Jersey City, N. J.

This paper reviews the work being conducted at the M. W. Kellogg Research Laboratory toward the development of improved curing systems, and easier processing compounds for Kel-F Elastomer.

The properties of both gum and specific compounds which influence their application will be discussed including recommendations for compounding, fabricating, and curing. Data concerning the development of a polyamine curative, HMDA-Carbamate, and its use with Kel-F Elastomer will be presented. The use of a high-melting fluorocarbon wax, Kel-F 200 wax, as a process aid in fabrication is a recent development which shows great promise.

Some of the specialty applications in which fabricated parts of Kel-F Elastomer are meeting severe requirements will be

discussed.

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11:05 a.m.—25. Properties of Fluorocarbon Elastomer 214. A. F. Wilson, C. B. Griffis, and J. C. Montermoso, Quartermaster Research & Development Center, Natick, Mass.

Military interest has recently increased in elastomers suitable for use at extreme high temperatures. Applications in some cases require contact with fuels and lubricating fluids. M. W. Kellog Co. and the Quartermaster Research & Development Command have developed a new rubber—Fluorocarbon Elastomer 214—a 70/30 copolymer of vinylidene fluoride and perfluoropropene. The material shows promising resistance to heat exposure, both in air and in fuels and lubricants.

Stocks compounded with peroxide, amine, and amine salt curing systems have been made. For comparison purposes, similarly cured compounds of Kel-F Elastomer 3700, a copolymer of chlorotrifluoroethylene and vinylidene fluoride, were used. The paper describes physical properties at 75° F., flexibility at low temperatures, and resistance to red fuming nitric acid. Volume swell values are given for a variety of liquid fuels and lubricants. The effects of heat aging in air and in the various chemical reagents are also given. Exposure times range from 5 to 70 hours, and temperatures from 220 to 600° F.

⁷M. W. Kellogg Co. trade mark.

CALENDAR of COMING EVENTS

April 12

Detroit Rubber & Plastics Group, Inc. Spring Meeting. Detroit Leland Hotel, Detroit, Mich.

Philadelphia Rubber Group. Poor Richard Club, Philadelphia, Pa.

April 14-27

United States World Trade Fair. Coliseum, New York, N. Y.

April 16-18

American Institute of Chemical Engineers, American Nuclear Society, American Society for Testing Materials, Society for Non-Destructive Testing. Symposium on Nuclear Tests for Non-Destructive Testing Applications. Morrison Hotel, Chicago, III.

April 16

Elastomer & Plastics Group, Northeastern Section, ACS. Trip to Dewey & Almy Co., Cambridge, Mass.

April 17

Washington Rubber Group. Pepco Auditorium, Washington, D. C.

April 26

Chicago Rubber Group. Furniture Club, Chicago, III.

April 29-May 3

American Material Handling Society Conference; Materials Handling Exposition. Convention Hall, Philadelphia, Pa.

May 7

The Los Angeles Rubber Group, Inc. Biltmore Hotel, Los Angeles, Calif.

May 9

Northern California Rubber Group.

May 10

Buffalo Rubber Group, and Ontario Rubber Section, CIC. International Meeting. General Brock Hotel, Niagara Falls, Ont., Canada.

May 14-16

Armour Research Foundation and Nucleonics Magazine Second Annual Industrial Nuclear Technology Conference. Museum of Science & Industry, Chicago, III.

May 15

Washington Rubber Group. Pepco Auditorium, Washington, D. C.

May 15-17

Division of Rubber Chemistry, ACS, and Rubber Division, CIC. Joint Meeting. Sheraton-Mt. Royal Hotel, Montreal, P.Q., Canada.

May 20-23

Design Engineering Show; Conference of Machine Design Division, ASME. Coliseum, New York, N. Y. May 21

Elastomer & Plastics Group, Northeastern Section, ACS. Annual "Short Talk" Symposium.

May 22-24

American Society for Quality Control. Eleventh Annual Convention and Exposition. Masonic Temple, Detroit, Mich.

May 24

Connecticut Rubber Group.

June 1

Southern Ohio Rubber Group.

June 6

New York Rubber Group. Outing. Doerr's Grove, Millburn, N. Y.

June 7

Fort Wayne Rubber & Plastics Group. Outing. Lake Tippecanoe, Leesburg, Ind.

June 7-9

The Los Angeles Rubber Group, Inc. Summer Outing. Sahara Hotel, Las Vegas, Nev.

June 9-13
American Society of Mechanical Engineers. Semi-Annual Meeting. Sheraton Palace Hotel, San Francisco, Calif.

June II

Buffalo Rubber Group. Outing.

June 14

Boston Rubber Group. Outing. Andover Country Club, Andover, Mass.

June 21

Akron Rubber Group. Outing. Firestone Country Club.

June 28

Detroit Rubber & Plastics Group, Inc. Outing.

August 1

New York Rubber Group. Golf Outing. Baltusrol Golf Club, Springfield, N. J.

September 11-13

Division of Rubber Chemistry, ACS. Hotel Commodore, New York, N. Y.

September 18-20

National Bureau of Standards, Catholic University of America, Applied Physics Laboratory of Johns Hopkins University. Symposium—"Formation and Stabilization of Free Radicals." National Bureau of Standards, Washington, D. C.

September 23-25

American Society of Mechanical Engineers. Fall Meeting. Hotel Statler, Hartford, Conn.

Akron Group January Meeting Program: Symposium on Testing-II*

Q. Discuss the merits of various raw tire-fabric fatigue testing methods.

A. Liska. Although much effort has been expended over a number of years in an attempt to develop raw tire-cord fatigue test methods, none has proved to be a very useful method for predicting fatigue performance of a cord in a tire. These tests are, however, of limited use to a cord manufacturer or supplier, providing him with a process control method and also means of establishing "ball park" fatigue resistance figures.

For example, almost any of the raw cord tests, such as the United States Rubber Co. test or the DB (dynamically balanced) test, it is believed, would enable a manufacturer to determine whether a tire cord made from some new material has very poor fatigue resistance (which would immediately remove it from further consideration), or whether its fatigue resistance is of the same order of performance as rayon, for instance. Such a preliminary evaluation would be particularly useful if the material presented some unusual adhesion problems which would require considerable experimentation before a "cured-in" fatigue test could even be considered. At least one of the large producers of rayon yarn has found the DB test to be a very sensitive process control test.

One explanation for the failure of a raw cord test to correlate with service flexing is based on the generally accepted theory of flex fatigue failure, which postulates that linear compression of the cord during part of the stress cycle is necessary to duplicate fatigue failure in tires. If this theory is accepted, the failure of raw tire cord tests to correlate with service flex fatigue is not difficult to understand, since none of these tests applies any significant amount of compression to the cord during the stress cycle.

Q. Discuss laboratory tests for evaluating "flat spotting" of nylon tires.

A. Dillon. There seems to be no established laboratory test for evaluating "flat spotting." although I'm sure that each manufacturer employs one or more tests to predict its magnitude. In this state of ignorance, it might be amusing to speculate a little on the nature of "flat spotting" and perhaps thus draw some facts from someone who is actually working with it.

"Flat spotting" probably results from "primary creep," i.e., reversible flow, of the nylon cords as they are held for considerable periods under abnormal stress in the contact region of the tire. The assumption is supported by the fact that "flat spotting" is reduced by "hot stretchwhich essentially eliminates the low modulus stress-strain region of the nylon fibers where primary creep can take place under very low stresses. It is also consistent with the experience that the effects of "flat spotting" disappear after a short distance of driving. Driving the car a short distance would serve to "cycle" the nylon cords and probably also produce a slight temperature rise; both effects would tend to reverse the primary creep deformation and bring the tire back into balance.

On the basis of this perhaps over-simplified analysis it appears that an appropriate laboratory method of evaluating "flat would be a simple creep test spotting" with the dipped, hot-stretched nylon cords held at a constant tension comparable with that causing the flow in the contact region of the tire. The rate and the extent of primary creep observed should be a measure of the degree of "flat spotting." and observation of the rate of reversed creep upon removal of tension should indicate the rapidity with which "flat spots" will disappear after the starting of the

This is only a theory, of course, and I should be happy to stand corrected by people who are actually working with nylon tires.

Q. What are the most significant lowtemperature tests, and how do they wave to the various low-temperature services?

A. Doner. The following low-temperature tests are used: brittleness by impact, brittleness by fast bend, torsional bend, low-temperature retraction. Young's modulus in flexure, and low-temperature compression set.

All of these tests provide information as to how a given compound will perform at low temperature and are valuable tools for the research compounder. But, from a practical point of view, the cold test should be conducted on the finished part because shape and the bulk of a part determine the stress which must be taken by the compound. For instance, I have seen hose fail miserably when flexed at -65° F. and made from compounds that passed all laboratory low-temperature tests.

Q. What is the best method of measuring the melting point or softening range of plastics such as polyethylene?

A. Blake. There are a number of possible methods of determining the softening range or melting point of polyethylene and similar plastics. The most widely used is the Vicat test. In this test the penetration of a one-square millimeter needle under a two-kilogram load is measured while the sample is heated so that the temperature increases at 50° C. per hour. The plot of penetration versus temperature gives a clear indication of the softening point. This test is probably the best

Another simple method of determining the softening point is to plot curves of hardness versus temperature, using a jigmounted Shore16 hardness tester. Sample, jig, and tester must be preheated in an oven at each temperature for about one hour before the sample is tested. A oneminute reading of hardness may be used.

Other tests which may be useful in

evaluating plastics for particular types of applications include a compression creep test or the torsional stiffness test which are covered by ASTM specifications.

Q. What testing equipment is available and recommended for evaluating resilient urethane foams?

A. Keen. The Flexible Urethane Foam Test Methods Subcommittee of the SPI17 Cellular Plastics Division has issued Proposed Tentative Specifications and Methods of Test for Flexible Urethane Foam. These methods include:

- (1) Indentation load deflection
- (2) Compression load deflection
- (3) Compression set
 - (a) Constant deflection (b) Constant load
- (4) Constant deflection flexing
- (5) Tear resistance
- (6) Density determination (7) Flammability
- (8) Tensile strength
- (9) Humidity aging

For some applications it has been found desirable to measure resilience in addition to conducting this series of tests. Resilience may be determined with a modified Yerzley oscillograph.18

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From these tests it will be noted that conventional equipment for evaluating foam rubber can be used to evaluate

resilient urethane foam.

Q. What kind of reproducibility should be expected in the usual physical tests (stress-strain, Mooney, etc.) in: (a) plant control test lab, (b) experimental test lab?

A. Scott. In answering a previous question. I believe I have covered stress-strain data both for plant control and experimental tests.

As far as the spread of Mooney values is concerned, we feel that if proper care is given in the milling and preparing of the specimen, a tolerance of plus or minus 0.5 Mooney point on viscosity and plus or minus 0.5 to one minute on scorch could be expected. Any variation in sample preparation would, of course, widen these tolerances.

Q. Discuss methods of evaluating staining and discoloration.

A. Keen. ASTM D 925-55 outlines methods providing standard conditions for producing and evaluating both contact and migration stains which may occur when vulcanized rubber is in contact with organic finishes under conditions of heat, pressure, or sunlight. Contact stains occur on the area in contact with the rubber. and migration stains occur on the adjacent

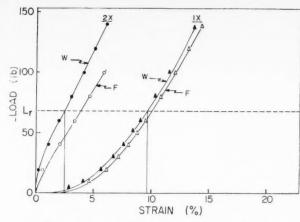
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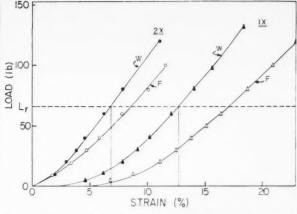
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MShore Instrument Co., Jamaica, N. Y.

MScociety of the Plastics Industry, New
York, N. Y.

MSASTM D 945-55.





for untreated cotton fabric. W designates warp direction; for cotton fabric wet out with distilled water and dried. F designates filling direction

Fig. 1. Typical uniaxial (IX) and biaxial (2X load-strain tests Fig. 2. Typical uniaxial (IX) and biaxial (2X) load-strain tests W designates warp direction; F designates filling direction

Briefly, the test for contact staining consists of placing a rubber specimen between two metal plates having the desired organic finish and subjecting the sandwich to a specific weight at a temperature of 175 ± 2° F. for a specified time. The test for migration stain consists of placing the rubber specimen on metal having the desired organic finish and exposing this assembly to a specified light source for a specified time.

ASTM D 1148-55 outlines the standard method of test for discoloration due to sunlight and heat of white or light-colored vulcanized rubber or vulcanized rubber covered with an organic finish. This test consists of exposing the specimen to a specified light source for a specified time. These methods are used extensively in the

A slight modification of these procedures is used in the development of compounds for white sidewall tires and similar decorative rubber veneers on such products as washing-machine and garden hose. In these cases the specimen is the decorative veneer vulcanized in contact with the substrate.

Q. What are the advantages of measuring the load-strain properties of a fabric in the warp and fill directions simultaneously?

A. Dillon. The theory upon which this so-called biaxial fabric testing is based is simply that most fabrics have to bear loads in warp and fill directions at the same time. Thus the simultaneously stressed warp and fill yarns interact in a complex manner which is not reproduced by conventional uni-axial tensile tests.

Several years ago at Textile Research Institute we developed a simple attachment for a conventional strain-gage tester which provides the same rate of jaw separation in warp and fill directions. Load and fabric strain in the central uniformly stressed region are measured only in the vertical direction, but by mounting half of the fabric samples with warp vertical and half with warp horizontal, the biaxial load-strain picture is obtained. Representative biaxial data for a square-woven cotton fabric, tested at 65% R.H. and 70° F.,

are shown in Figure 1.19

As would be expected, the "uncrimping" region characteristic of uniaxial tests is not present with the biaxial tests for which the warp and fill load-strain curves rise steeply from the origin. Obviously, this fabric would be considered very balanced, according to the uniaxial test. This does not prove to be the case, however, when the more realistic biaxial test results are considered. Tests with the same fabric which had been wet-out with distilled water and dried are shown in Figure 2. Here the fabric appears unbalanced in both uniaxial and biaxial tests.

A more elaborate biaxial testing device recently developed by Fabric Research Laboratories, Boston, Mass. With this device the rate of loading rather than rate of jaw separation is controlled in warp and fill directions, and very interesting results have been obtained which could never have been predicted from conventional uniaxial tests.20 In general, then, biaxial testing is highly informative, but it must be admitted that all methods thus reported are rather fussy and would be difficult to use in routing testing.

Q. What is the latest thinking on the sensitivity and the reproducibility level of the various "tear tests" for rubber and plastics as they relate to actual performance of such materials?

A. Liska. From the viewpoint of a laboratory test, with no reference to actual prediction of probable finished product performance, the sensitivity and the reproducibility of the several tear tests more or less generally used in the rubber and plastic industry appear to be somewhat poorer (though not by a large amount) than those of the conventional tensile strength test. The degree to which the several tear tests can be related to actual performance varies widely and in most cases is probably quite low. As a matter of fact, the sensitivity and the reproducibility of any given tear test are closely related to actual performance only in those isolated instances where the service conditions happen to subject the product to the same type, rate, and extent of deformation which are characteristic of the

test procedure itself.

Some very recent work has been carried out relating tear resistance and modulus to abrasion resistance. More data are needed, however, before any definitive statements can be made about this aspect of tear testing.

Q. Would an oven aging test, preceding a "cold" test, be more indicative of the true value of the compound to perform in actual service?

A. Doner. Yes, because an oven aging test would drive out any low-boiling or fugitive plasticizers which may have been used to improve the material's low-temperature properties.

There are products that are never subjected to high temperatures in service. In such cases the use of an oven aging period prior to cold testing might disqualify a perfectly good product.

Q. Explain the effect of different temperature levels when running compression set (such as ASTM D 395-55-Method B), and what are the most common temperatures used when running ASTM D 395-55 -Method B?

A. Doner. The compression set values for a given compound become poorer as the test temperature is increased. For example, a natural rubber stock tested at 158, 212, and 300° F. could show 25, 60, and 100% set, respectively.

Compression set tests are usually run at the following temperatures (° F.) for the various rubbers.

Natural ru	ıb	b	e	r.								158			
SBR												158	and	212	
Neoprene											۰	158			
Nitrile												212	and	250	
Silicone												300	and	350	

Either 24- or 70-hour heating periods at 158, 212, 250, and increments of 50° F. above are generally used for compressionset tests.

Q. What is the best general hysteresis

¹⁹ H. K. Woo, J. H. Dillon, J. H. Dusenbury, Textile Res. J., 26, 761 (1956).

²⁰ W. G. Klein, "Biaxial Stress-Strain Resonose of Fabrics," presented before The Fiber Society Spring Meeting, May 2 and 3, 1956, Clemson, S. C.

test for rubber and plastic compounds and combinations thereof, and what new equipment is available for such testing?

A. Keen. Hysteresis in the rubber industry is considered to be the % energy lost per cycle of deformation, or 100% minus the resilience percentage. Let us consider three methods of obtaining a measure of hysteresis:

(1) The area within the low-speed stress loop, expressed in energy units, is a measure of hysteresis. This loop is obtained by loading and unloading a specimen in tension, compression, or shear, using a low rate of strain and large deformation.

Since most practical applications involve vibratory stresses of relatively high frequency and low amplitude, this method of measuring hysteresis is not often used. In places where it is applicable, hysteresis in energy units can be obtained directly by use of an integrator such as the one supplied with the Instron tester.

(2) % resilience may be obtained by use of the Yerzley oscillograph. This method of determining hysteresis has greater utility since it involves low amplitude and relatively high-speed deformation by comparison to the stress-strain loop.

(3) % resilience may also be obtained by instruments such as the Lord Mfg. Co. dynamic modulus tester which operates at low amplitudes and frequency range of from 1-60 cycles per second.

The "best" method for evaluating a given composition depends on the application involved.

Q. What is a good test to evaluate the green tack of a rubber compound?

A. Cooper. Evaluation of adhesion to itself is most satisfactory. However, the technique in producing the union is the key to the reliability of the test. The test pieces should be subjected to closely controlled atmospheric and aging conditions similar to those encountered in production before assembly. In building or plying up the test sample, contamination of any kind on the surface, including finger marks. must be avoided. Pressure should be applied by a roller operating under a deadweight load or a calibrated spring load. This is the most important part. After the test specimen has been prepared any one of several machines can be used to measure the force necessary to separate the plies.

Q. Are fabrics made of the newer synthetic fibers immune from attack by insect pests?

A. Dillon. In general, the newer synthetic fibers are not attacked by common insect pests such as the larvae of the clothes moth and the carpet beetle. If, however, moth larvae happen to be imprisoned by a nylon fabric, they will eat their way through it to get to a delicious woolen sweater, i.e., the nylon is not digestible, but neither is it impervious to insect attack when it bars the way to a meal that is coated with a toothsome finish.

Q. What physical tests would you recommend for field service correlation with tire ride and squeal?

A. Cooper. Since tread design and tire

construction are the important items on this problem no laboratory test can be recommended.

Q. What is the value of a laboratory abrasion machine, and what correlation can be expected with fleet tests?

A. Liska. This question is probably one of the most controversial put to the panel. Although I believe my own views are expressed fairly well in the previous discussion, a few additional words of explanation may not be amiss. There has been considerable activity in this field recently. and good correlations between laboratory abrasion tests and fleet results have been claimed. Inspection of the published results, however, shows that only a limited number of compounds has been tested in most cases, and even these have generally been on limited types of compounds (i.e., limited to one or two base elastomers). Even in those cases where correlations are shown, variations of plus or minus 20% are not unusual. Further tests, on a wider variety of compounds, would almost certainly increase this variation and reduce still further the reliability of any prediction based on laboratory test results. Perhaps improvements can be made on the present techniques which will significantly reduce the observed variations, but my own view is that this is not very probable.

Q. What laboratory dynamic test correlates best with high-speed tread cracking of synthetic treads (90 m.p.h.)?

A. Liska. This question would probably be answered differently by every technologist involved in this area of testing activities. As nearly as can be determined from a brief survey, the standard De Mattia test. or some modification of it, is being used with a fair degree of success in predicting high-speed tread cracking of synthetic tires. Not all laboratories are satisfied with the degree of correlation obtained with this test, and several are still experimenting with some form of groove cracking test in which some attempt is made to simulate in the test sample all of the flexing features which the tread is subjected to under service conditions. None of these, however, is widely used, and in most cases the extent of correlation has not been nublished

Q. What is the industry evaluation of the "Zwick" hardness tester? Is it acceptable as a replacement for the Shore type?

A. Doner. The "Zwick" hardness tester is virtually a quadrant shaped type "A" durometer made in Germany. It is acceptable as a replacement for the Shore instrument.

Q. How are tensile, modulus, and elongation related to dumbbell dimensions, test temperature, and rate of elongation?

A. Scott. There is considerable information published primarily by one of the Armed Services and by a chemical company on the effect of temperature upon these values. Basically it is safe to say that as temperature rises, the specimen gets softer, giving higher elongation values and lower tensiles. As the temperature goes down, the tensile strengths increase appreciably, but the elongation diminishes

until, or course, we reach the brittle point where elongation is non-existent.

As far as the effect of speed upon the physical properties, this was fairly well covered in a paper of which I was coauthor with D. S. Villars, which was given as part of a Symposium on Speed of Testing before the American Society for testing Materials annual meeting in 1956. To summarize briefly, at a 30 seconds time to break, as the conventional tester allows, a tensile of 3,900 psi, and an elongation at break of 650% were observed, but at 28 milliseconds the same stock showed a tensile of 1,900 and an elongation of 1,300. Above that speed, however, there is a decided increase in tensile, SBR, for instance, by sevenfold over that of the standard test.

In hard rubber, some work was done at Hood Rubber Co, which shows that a 600% increase in speed added only 30% to the tensile and 80% to the elongation.

Q. How soon will elongation between bench marks be automatically recorded on charts in connection with tensile tests? Will there be more extensive use of automatically recorded or charted data?

A. Scott. I personally ran a Scott tensile tester in a well-known rubber laboratory for eight hours a day for five consecutive days and at that time reached the conclusion that there must be some way this work could be done automatically. To date, my findings can be summarized as follows: unless physical contact to the specimen can be permitted so that the spread between these contact points can be evaluated, no means is available. Because vulcanizates under tension are susceptible to cutting, I do not believe that this contact should be tolerated.

For the past six years I have been actively engaged in talking, sketching, and otherwise coping with this problem of recording bench marks with people in many pursuits. Unfortunately, to date we have nothing to offer. We do, however, feel that we are along the road to a conclusion.

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In answer to the second part of this question, automatically recorded or charted data are becoming more prevalent for many values, probably owing to the expansion of facilities in personnel and the need of tabulated data suitable for transmission from the point of test to the desk of the evaluator. From personal experience I can say that in 1948 we were shipping approximately 400,000 chart forms a year; during 1956 we shipped more than 1,350,000, and our recorder sales for the Mooney viscometer increased by 500% within a similar period.

Q. What are the effects of nuclear radiations upon the physical properties of textile materials?

A. Dillon. This field of research is rather new, of course, but already some interesting results have emerged. In general, the effects of high energy radiations on fibrous polymers involve two principal reactions which probably take place simultaneously in varying relative degrees: cross-linking and chain scission. Where cross-linking and chain scission, the melting point of the polymer rises; the breaking tenacity and modulus increase, and the extensibility

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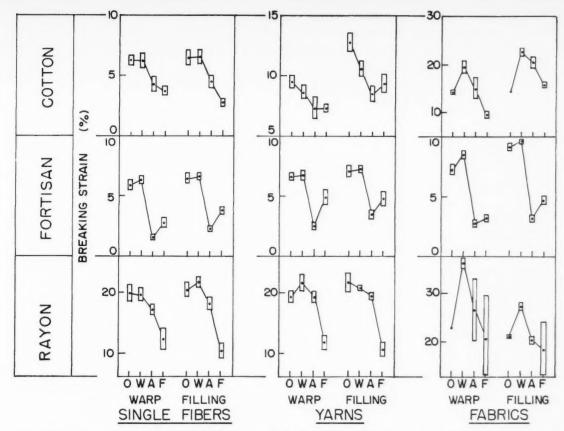


Fig. 3. Breaking strain vs. treatment. O designates original untreated; W, water-treated; A, acid-treated; F, formaldehyde-treated

decreases. Thus, the cross-linking results in a fiber of increased strength, but it may also cause serious embrittlement. The competing reaction of chain scission tends to reduce strength, and there is no evidence that anything but damage occurs.

The information already published suggests certain definite correlations between the effects of irradiation and chemical structure. Long-chain hydrocarbon polymers and polymers with no side-chains other than phenyl groups are predominantly cross-linked, for example, polystyrene and polyethylene. Cellulose and polymers containing halogens are badly damaged by irradiation, indicating predominant chain scission. Polyesters and polymides appear to be intermediate in stability.

A recent paper by Teszler and Ruther-ford²¹ indicates that the degree of fiber orientation is also important in determining the effects of irradiation. Working with Dacron fibers with various drawratios, these authors showed that more cross-linking, as measured by elastic modulus, occurs at the lower draw-ratios, with both neutron and gamma irradiation. This result seems to be at variance with the concept that cross-linking is promoted by high orientation, i.e., increased average proximity of cross-linkable groups in the polymer chain.¹⁹

Q. Please outline the test methods used in determining curing rate of vulcanized foam rubber products. Outline tensile strength and elongation test methods for films made of compounded latex.

A. Keen. Two methods are currently being used, and both are considered satisfactory. One method uses a doughnut-shaped specimen that is pulled on a testing machine immediately following the steam cure while the specimen is hot. The strength of the hot wet foam is used to indicate the state of cure.

The other method uses a conically shaped specimen which is given a steam cure, washed, and then passed through a wringer roll set at a fixed opening. As would be expected, the undercured section of the specimen takes a permanent deformation, and the distance from the apex of the cone to this point of deformation indicates the state of cure.

If more accurate data are needed, or if state of cure information is desired on the dry cure, then compression set test or an analysis to obtain the combined sulfur should be used.

ASTM does not have a procedure for either preparing or testing latex films. ASTM Committee D-11 subcommittee 7 and the SAE-ASTM technical committee on Automotive Rubber subsection are currently working on the problem of film preparation. It is believed that the industry follows the procedure in ASTM D 412 for determining stress-strain characteristics in tension of latex films, even though these are excluded in the scope.

Most laboratories use the Scott Tester Model L-5, having a capacity of 60 pounds with the dynamometer head of the compensating type. More consistent results have been obtained in the testing of latex films by gaging the specimens more accurately and setting the compensating weight of the Scott tester accordingly.

Q. What is the order of importance of the various electrical properties for general screening of plastics and rubbers for electrical applications?

A. Blake. The relative importance of the electrical properties in screening rubber and thermoplastic materials depends on the particular application. The properties which define an insulation for power cables are not necessarily those required for communication cables or for such electrical items as switchboard matting, building wire, or electric blankets.

Four principal electrical properties characterize the usefulness of an insulation:

(1) Dielectric strength, This is a measure of the ability of an insulation to withstand voltage. It is a function of dimensions, temperature, time of voltage application, kind of voltage (a.c., d.c., or impulse).

(2) Electrical resistivity. This is a measure

(2) Electrical resistivity. This is a measure of the resistance offered by the insulation to the leakage of current through it. It varies with voltage stress and temperature.

(3) Dielectric constant or specific inductive capacity. This quantity is the ratio of

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²¹ Textile Res. J., 26, 796 (1956).

the capacitance of an insulation in a particular configuration to that of a capacitor identical in dimensions, but using air as a dielectric. It is the ability of the dielectric to store an electric charge. It varies with temperature and frequency.

(4) Power factor. This property measures the proportion of the charging current in a capacitor or a cable which is dissipated in the form of heat and therefore is lost. It is a function of frequency. temperature, and voltage stress.

All of these should be of a proper initial value and then should also remain stable under various operating conditions. Electric wires and cables, for example, are frequently immersed in water, exposed to chemicals, buried directly in soil. exposed to high temperatures, and subjected to other environments which may deteriorate the insulation. In general, the dielectric strength and resistivity should be high. while the power factor and dielectric constant should remain low. It is not always possible to obtain the best values of all these properties in any one compound. In many cases a compromise will be needed to give the material best suited technically and economically to the job at hand.

In the case of high-voltage power cables, the initial dielectric strength should be high and should be well maintained throughout its service life. If the dielectric strength decreases below operating voltage, the cable fails. In addition, power cables require an insulation having a reasonably low dielectric constant and power factor so that hysteresis losses due in the insulation will not be excessive.

In communication cable or control cable dielectric strength is usually not a problem. The requirement of low transmission loss is important. For this reason, dielectric constant and power factor must be low initially and remain stable over long periods of time.

Besides electrical wire and cable, many other applications of rubber and thermoplastics require electrical properties. In molded terminals or bushings, for example, not only is dielectric strength and power factor important, but resistance to tracking on the surface of the material is a critical factor.

Q. Is it possible to predict fabric performance from knowledge of the mechanical properties of the constituent fibers?

A. Dillon. Prior to Harold DeWitt Smith's historic Marburg Lecture in 1944, "Textile Fibers, An Engineering Approach to their Properties and Utilization." 22 the answer which most textile technologists would have given to this question would have been an unqualified no. Since that time many things have happened in fiber technology. Most of the important synthetic fibers were developed on the basis of qualitative concepts of fiber-fabric relations. Now intensive work is being done to develop quantitative relations.

The major stumbling block in solving this problem is the complex geometry of fibers in yarns and yarns in fabric. Significant progress has been made, particularly by Hamburger and his colleagues, of Fabric Research Laboratories, in this field,23 and other organizations realize that is a key problem, not only for the producer

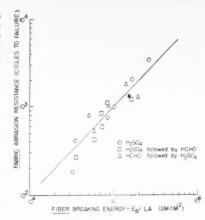


Fig. 4. Fabric flex abrasion vs. single fiber energy to rupture

of synthetic fibers, but also for the wool grower and the cotton breeder. All fibers, natural and synthetic, must eventually be supplied according to engineering specification for given end-uses.

We cannot afford the time to discuss in detail this currently active field, but it might be interesting to examine a few cases where the geometry bugbear has been substantially eliminated. Let us first consider the case 19 of three light fabrics of cotton, Fortisan,24 and viscose rayon which were tested under four different conditions, designated as follows:

O-original untreated

W-wet out in distilled water and dried A-padded with pH 2.0 HC1 solution and dried

F-padded with 7.5% HCHO solution at pH 2.0 and baked 30 min. at 110° C.

Yarns and single fibers were teased from both the warp and the filling of these fabrics and tensile tests were made on single fibers, yarns, and fabrics at 65% R.H. and 70° F. Only one of the various tensile properties measured, breaking strain, is shown in Figure 3. The vertical dimensions of the rectangles at each experimental point indicate the respective precision of the corresponding group of measurements. There is a very heartening correlation among the breaking strain values of single fibers, yarns, and fabrics under the four conditions of fabric treatment. This correlation is most impressive with Fortisan where its greater stability upon swelling with water minimizes fabric-geometry changes in the O-W transition. Other tensile properties measured-breaking stress, elastic modulus, and toughness-behave in about this same manner.

As a second case of fiber-fabric property correlation, let us examine the flex abrasion (Stoll tester) of a wool-worsted fabric which was degraded with acid in various degrees. Wool fibers were teased from the fabric after each acid treatment and the tensile properties were measured wet. The graph of Figure 4 giving fabric abrasion cycles vs. fiber breaking energy is a beautiful illustration of the fact that single fiber properties do govern fabric performance, provided horse-sense is properly

Unfortunately, the geometrical prob-

lems which enter into the situation under practical conditions call for more than horse-sense power, but we now have many able people working in this difficult field; Harold Smith's ultimate objective, engineering design of fabrics in terms of fiber properties, now seems to be approaching realization.

Q. Discuss the methods used for cold and hot, static and dynamic tests of rayon and nylon tire cord adhesion.

A. Liska. The simplest static cord adhesion test used is one in which several cords, spaced about 1/16-inch apart, are molded in or near the surface of a fabric reinforced pad and are then pulled out of the slab one at a time. The average force required to separate the individual cords from the rubber is used as a measure of the static adhesion. Another somewhat similar method is the strip pull-down test. In this test, cord fabric is cured into fairly sizable pads, usually reinforced on both sides by square-woven fabric. These are then cut into narrow strips parallel to the direction of the cord fabric. Again, the average force required to pull the strip apart at the cord fabric rubber interface is taken as a measure of the static adhesion force.

The method which is probably most widely used today, for determining both hot and cold static adhesion of tire cord to rubber is the so-called "H" test. This method was originally described by Lyons, Nelson, and Conrad.25 This method has a number of advantages over most of the other tests used, not the least of which is the fact that a specific adhesive force can be calculated which is independent of the diameter of the test cord used. Also the force thus measured is less dependent on the tensile properties of the compound used to make up the test pads than is the case in other tests. Furthermore, the test is relatively easy to perform, and special molds have been designed and built to facilitate and speed up the testing pro-

A number of dynamic adhesion test methods have also been described in the literature. Most of these are basically similar to each other in principle. The test specimen is usually subject to some type of oscillating deflection designed to weaken or deteriorate the bond between the curedin cords and the rubber, following which the adhesive force is measured. Comparison of this force with that obtained on an unflexed specimen is presumed to be a measure of the dynamic cord adhsion. New methods are currently being tried, but so far none has been widely adopted or generally accepted as yet.

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Q. What physical tests will show adequate cement adhesion for tire tread splices and tread-to-carcass adhesion in field service?

A. Cooper. Field service is definitely spelled out in the question, and field serv-

"Smith, Harold Dewitt, "ASTM Proceedings." 44, (1744).

23 Walter J. Hamburger, "A Technology for

water J. Hamourger, "A Technology for the Analysis, Design, and Use of Textile Struc-tures as Engineering Materials," Edgar Mar-burg Lecture, 1955. Published by American Society for Testing Materials. "Celeanse Corp. of America trade mark. "India Rubber World, 114, 213 (1946).,

ice infers elevated temperature. Therefore a machine for this test (I do not believe any are commercially available) must operate at elevated temperatures and subject the test sample to repeated separation pulls at stress less than the force necessary to produce complete separation on an initial pull. No standard physical test evaluates the desired property, and other than actual road test there is no generally accepted evaluation.

Q. What physical tests will allow the development of tread compounds which will not "heat blow" in high-speed airplane tires?

A. Liska. In general, three distinct types of tests are required. First of all, some test to determine the rate of heat generation of the tread compound is required in order to enable the compounder to select those compounds which produce the least heat. Secondly, some type of aging test is required to determine the rate of change of heat generation (and other features) with progressive oxidation. Finally, some kind of "thermal stability" test must be performed to establish the rates of degradation of the compounds in question resulting from heating alone, independent of oxidation as such.

Some of the "blow-out" tests currently in use combine all three of these aspects into a single, completely empirical test procedure. If such a test does not always predict probable product blow-out performance of the compounds involved, one should not be too surprised.

Q. In conveyor belting, is it possible to correlate fabric flexibility with belt flexibility to be able to predict troughability? What is the lowest degree of fabric flexibility or belt troughing which is acceptable in conveyor belting?

A. Doner. The flexibility of the fabric in a conveyor belt undoubtedly has some influence on the troughability of the belt. but several other factors, such as number of plies, thickness of skims, hardness of cover, and width of belt, must be considered when discussing troughability.

To my knowledge no definite means of troughability has ever been devised.

O. Do high tensions in the dipping of rayon conveyor-belting duck fabrics, with resulting low fabric elongation, materially affect the performance of a conveyor belt?

A. Doner. I would say that it would not materially affect a belt's performance. The trend, however, seems to be to allow the rayon fabric to shrink during the dipping operation and then to remove the excess shrinkage during the curing of the

Rubber Extruder Discussed By Hovey at Connecticut

"The Past, Present and Future of Rubber Extruders" was the subject of a talk given by V. M. Hovey, John Royle & Sons. Inc., before 225 members and guests of the Connecticut Rubber Group at Manero's Restaurant, Orange, Conn., February 15.

Extrusion had its beginnings in the United States in 1880 with the introduction of the first tubing machine by John Royle & Sons, Mr. Hovey said, with the basic principles of design laid down then still being used in all extruding machines of today, although extruders have been improved and enlarged.

The development of various parts of the extruder, such as driving mechanism, thrust bearing construction, feed throat design, cylinder types, screw characteristics and head design was traced and illustrated with slides.

In the early days, cylinders were of non-extended length, but with the advent of the Western Electric room temperature process, cylinders were extended, and the extruding machine was made to do the work formerly accomplished by a mill. This process, which utilizes rubber feed at room temperature, is becoming increasingly more popular because of the advantages it offers over the old hot feed method, according to Mr. Hovey.

In the early days cylinder temperature control was not considered a serious problem, but in terms of today's extrusion methods and multitude of compound types. each with its own characteristics, temperature control has become of utmost im-

Modern Royle machines, Mr. Hovey pointed out, are electrically heated and evaporatively cooled; both phases are controlled automatically through the panel board. Thus the high precision of control required is obtained simply and reliably.

Mr. Hovey declared that refinements of head and fixture design, further improvements in stockscrew characteristics, and higher extrusion speeds seem the most obvious developments for the near future.

Officers of the Connecticut Rubber Group for 1957 are as follows: chairman, Harry Gordon, Bond Rubber Co.; vice chairman, R. T. Zimmerman, R. Vanderbilt Co.; secretary, Vincent P. Chadwick, Armstrong Rubber Co.; and treasurer, William Couch, Whitney Blake Co. Directors are George Sprague, B. F. Goodrich Co.; Donald Cummings, General Electric Co.; Warren Carter, Pequanoc Rubber Co.; George Gerolman and James R. Boyle, both of Armstrong Rubber.

Carbon Black and Patents Subjects of Buffalo Talks

A talk on carbon black and one on patents featured the March 5 meeting of the Buffalo Rubber Group at the Hotel Westbrook, Buffalo, N. Y., March 5.

Attendance was 97 members and guests. Speaking on "Some Aspects of Carbon Black," Walter Smith, Godfrey L. Cabot, Inc., emphasized the importance of knowing the degree of dispersion of carbon black in milled rubber by detailing the procedure for its determination originally developed by Dunlop Rubber Co., Ltd., in England.

Moving to the electrical conductivity of carbon black. Dr. Smith said that these properties may be determined by counting the number of connected or closely associated carbon black particle paths. He used electron microscope photographs as illustration.

This speaker further declared that a perfectly random dispersion of carbon black in rubber is the most probable configuration. A 98% dispersion was considered to be the highest level one can reach, with further milling not increasing the percentage.

Malcolm Buckley, a chemical patent attorney with the law firm of Bean, Brooks, Buckley & Bean, warned that every patent should have a copyright to protect the inventor from having parts of drawings or diagrams stolen. No examination is required for this, but two copies of the patent should be filed in the Congressional Library.

Another important feature of the patent is the trade mark. This should be in capital letters and enclosed in quotations and should be a close-to-the-line description of the product or process. Legal means should be employed to enforce respect for the trade mark.

The cost of obtaining a patent may vary from as little as \$300 to \$25,000 or more. Government charges are \$30 for the patent application and \$30 for the final fee. The balance of the costs is for attorney fees. It takes about 31/2 years to get a patent.

Vinyl Talk Given by Semon At Northeastern Section

Waldo L. Semon, director of polymer research, The B. F. Goodrich Co., Research Center, Brecksville, O., addressed 100 members and guests of the Elastomer & Plastics Group, Northeastern Section, ACS, at the Museum of Science, Boston, Mass., February 19. His subject was "The Early Days of Vinyl Plastics-We Are Still in Them."

Dr. Semon outlined the history of vinyl plastics, beginning with the Dutch discovery of vinyl chloride in 1795 and including his own early studies of vinvl chloride in 1926 as a possible source of metal-torubber adhesives.

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He discussed such technical developments over the years as the introduction of plasticizers, Koroseal, stabilizers, the work of E. B. Newton in developing a PVC water dispersion using peroxides, the production of PVC from acetylene and hydrogen chloride, the perfection of foams and latices, and the development of plastisol casting methods.

More recently, Dr. Semon indicated, vinyl film has been used as a moisture barrier under concrete in building construction, as an underlay in roof flame-proofing, as an extruded water-stop and concrete interlock member; while PVC has been used as acid-exposed piping, vacuum-molded road signs, and in naval installations for radioactive fallout decontamination.

Declaring that vinyls have only just begun to find their economic niche. Dr. Semon predicted that consumption of the plastics would rise from their current 557 million pounds a year to one billion pounds a year by 1960.

Dunkel, Havenhill Address Boston Rubber Group

Walter L. Dunkel, Enjay Laboratories, and Robert S. Havenhill, St. Joseph Lead Co., addressed 200 members of the Boston Rubber Group at the Somerset Hotel, Boston, Mass., March 15.

Speaking on "Butyl Rubber—The Polymer and the Vulcanizate," Mr. Dunkel covered such topics as the unsaturation of butyl rubber compared to natural rubber, methods of increasing the rate of vulcanization of butyl and measuring the state of cure by swelling methods, and the effects of various acceleration combinations and blends with SBR on dynamic properties, on abrasion resistance, and on heat and ozone resistance.

The relation of structure to gas permeability and resilience of various polymers was indicated by the Enjay researcher. The advantages of Monsanto's Elastopar in butyl compounding was also pointed out. Mr. Dunkel concluded his talk with a prediction that the market for butyl rubber would continue to grow.

Mr. Havenhill, whose subject was "Electrostatic Potentials in Internal Mixers," demonstrated the electrostatic contact potential measuring devices perfected by his company for examining the contact potential of various rubber compounding ingredients and for following the course of mixing within a laboratory Banbury.

He illustrated the important effects that contact potentials produced during Banbury mixing and concluded with illustrations of the changes secured with surface-treated zinc oxides over ordinary zinc oxides.

The speakers were introduced to the assemblage by Arthur I. Ross, American Biltrite Co., Group chairman.

Guest speaker Irv Wermont talked on "Psychology in Action" before 350 members and guests at the evening dinner-meeting.

Joint Adhesives Symposium Hears Three Talk at MIT

The Northeastern Section of the American Chemical Society and the Elastomer & Plastics Group of the Section jointly sponsored a symposium on "Adhesives" at Massachusetts Institute of Technology, Cambridge, Mass., March 14.

With Herman P. Meissner, MIT, as chairman, the 200 members and guests in attendance heard Irving Skeist, Skeist Laboratories, speak on "New Direction in Adhesives," and Clinton M. Doede, Quantum, Inc., speak on "Bonding by Forming Polymers on Free Radicals at the Metal-Adhesive Interface." Charles G. Overberger, Polytechnic Institute of Brooklyn, addressed an evening session.

Dr. Skeist summarized conditions governing the selection of adhesives: crystallinity of plastics, use of monomers or solvent cements, polymer-type adhesives for dissimilar plastics, the importance of films more flexible than the adherends, correspondence of solubility parameters of

solvents and polymers, limitation of lowboiling solvents to reduce crazing, and use of non-migrating plasticizers or harder plasticized items.

The speaker stressed the importance of crystallinity in selecting solvent and adhesive materials. The final controlling factors considered were the effect of solvent systems on plastic crazing effects and the steps required for bonding dissimilar materials.

Concluding. Dr. Skeist summarized the rheological properties of adhesive solvent solutions and latices and considered the rising role of epoxy-modified adhesives of various types and their advantages.

Dr. Doede discussed some aspects of mechanisms and models of adhesion on the micro scale and indicated with slides some of the forces encountered at the interface and their distribution. He then described a method used by his group to examine the effects of various monolayers on the adhesion to solid brass blocks of a number of substances polymerized in place.

Using a film balance, the brass blocks were coated with the monomer in question by withdrawing through a monomolecular film on water. The thickness of the layers was checked with Johanssen blocks, and on these layers were laid cylinders of the same material; the whole coating was polymerized with ultra-violet light, with radiant energy, or with a low-temperature curing system.

No samples separated at the polymermetal interface, and the bond secured through a monlayer was found to be less strong than the one secured by direct polymerization to the solid brass surface.

An evening technical session, attended by 175 members and guests, heard Charles G. Overberger speak on "New Oxidation Reactions of 1.1- and 1,2-Disubstituted Hydrazines." Edward R. Atkinson, Dewey & Almy Co., was chairman of this meeting.

Statistics Methods Course

A one-week short course in "Statistics Methods for Research Workers in Industry and the Physical Sciences" will be held at Brevard College, Brevard, N. C., June 3-7, under the sponsorship of the North Carolina State College of Agriculture & Engineering of the University of North Carolina, Raleigh, N. C.

The course will run in two sections, an elementary and an advanced. Lectures in the elementary section will cover basic concepts, confidence limits, tests of significance, correlation and curve fitting, analysis of variance, and an introduction to design of experiments.

Among the topics included in the advanced section will be variance components, multiple regression, response surface methods, experimental design, and analysis of organoleptic experiments.

A registration fee of \$100 will be charged. Enrollment will be limited to 50 students in each section.

Registration information may be obtained from the Institute of Statistics, North Carolina State College, Box 5457, Raleigh, N. C.

Reclaimed Rubber Talk by Midwest's Ball at Tlargi

John M. Ball, Midwest Rubber Reclaiming Co.. spoke on "Compounding Reclaimed Rubber" before 80 members and guests of The Los Angeles Rubber Group Inc., at the Biltmore Hotel, Los Angeles, Calif., March 5.

Mr. Ball listed the advantages of reclaimed rubber as attractive price, stable price, uniformity, short mixing time, low power consumed in mixing, low heat developed in mixing and subsequent processing, fast processing, low thermoplasticity, dimensional stability, fast curing rate, minimizing of reversion, and good aging.

The use of reclaimed rubber in conjunction with oil-extended SBR was recommended and illustrative data were given. SAE-ASTM R tables were discussed, and the use of reclaim with SBR to give a range of tensiles and volume costs was detailed.

Mr. Ball pointed out that volume costs, important as they are, are only part of the cost picture, since processing costs can also be of equal or greater importance. Citing one example, the speaker said that if two compounds have the same tensile properties and volume costs, the one containing reclaim will usually be the less expensive because of its better processing properties.

Ed Kantor, Western Insulated Wire Co., was after-dinner Master of Ceremonies. Guest speaker was Mrs. John P. McGregor, who discussed "On Understanding Women." Attendance at dinner totaled 230 members and guests.

Group members voted down a resolution permitting the expansion of membership to include representatives of nonrubber industries.

Rubber Symposia Feature Second Southern Meeting

"Processing" and "Reinforcement of Rubber with Fabric" were the subjects of two symposia presented at the second meeting of the Southern Rubber Group at the Statler Hilton Hotel, Dallas, Tex., February 8 and 9. Attendance at the two-day conclave totaled 202, including 62 new members.

Moderated by G. H. Boeder. The B. F. Goodrich Co., the symposium on "Processing" included the following papers: "Banbury Mixing," C. R. Washburn, The Goodyear Tire & Rubber Co.; "Mill Mixing," D. H. Cowan, Goodrich-Gulf Chemicals, Inc.; "Calendering," M. M. Baker, The Firestone Tire & Rubber Co.; "Extrusions," R. L. Turpen. Bowling Green Rubber Co.; and "Processing Equipment." R. N. Comes and H. C. Chase, Farrel-Birmingham Co.

With George D. Hutchinson, Armstrong Tire & Rubber Co., moderating the symposium on "Reinforcement of Rubber with Fabric," the following talks were given: "Utilization of Nylon and Dacron." Howard Brokaw, E. I. du Pont de Nemours & Co., Inc.; "Utilization of Rayon," A. B.

(Continued on page 99)

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RUBBER WORLD

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NEWS of the MONTH

Washington Report and National News Summary

- ... Vinson Bill for quick disposal to industry of Louisville alcohol-butadiene plant hits snag; opposition in Senate led by Publicker Industries may delay sale until 1958.
- ... Disposal decision on Akron Government Laboratory and Pilot Plant may not be reached until summer.
- . . . Long-pending federal suits against manufacturers and marketers of tires and tubes in connection with quantity-limit rule discounts thrown out by D. C. Court of Appeals on technicality.
- . . . Federal Trade Commission's investigation of tire, battery, and accessories marketing delayed, and scope of investigation broadened.

- . . . Rubber Manufacturers Association campaigns for more tariff protection for footwear industry. Association also campaigns against Robinson-Patman Act amendment which would remove "good faith" defense in price discrimination suits.
- ... Federal Maritime Board asked to approve pooling agreement on rubber shipping rates among American and foreign lines that averted rate war.
- . . . U. S. Rubber's Humphreys decries government's recent reversion to taxing and spending philosophy and policies of the past.
- . . . Rubber industry production, sales, and inventory growth and changes for 1955 and 1956 surveyed.

Washington Report

By ROBERT E. L. ADAMSON

Quick Disposal Louisville Butadiene Plant Opposed; Senate Group Asked to Withhold Vinson Bill Action

In a hurry to sell off the last of its synthetic rubber plants—the 90,000-ton capacity alcohol-butadiene plant at Louisville—the Administration ran smack into a blow to the body in March which threatened to stall a sale until next year. The blow was delivered by an expert team organized just for the occasion—farm bloc Senators anxious to dispose of huge grain surpluses and Publicker Industries of Philadelphia, present lessee of the Louisville plant and bitter opponent of a sale now without the restriction that it be used to produce butadiene.

Vinson Bill Opposed 1

The bill authorizing the Federal Facilities Corp. to unload the plant by mid-summer was hustled through the House Armed Services Committee and through the House itself early in the Congressional session. based. This caught the support of farmminded Senators, including Homer Capehart, Indiana Republican, and Paul Douglas, Democrat of Illinois, both key members of the Senate Banking Committee which must approve the Vinson bill. At the same time the Banking Committee received a letter from the Presidential Commission on New Industrial Uses for Agricultural Products urging Congress to withhold action on the Vinson bill reaction the

Publicker, which was not given an audience

by the bill's author, Armed Services Chair-

man Carl Vinson, Georgia Democrat, held

back its knockout punch until the bill

reached the Senate. Then it circulated a

plan to utilize surplus grains to produce the

alcohol upon which Louisville butadiene is

received a letter from the Presidential Commission on New Industrial Uses for Agricultural Products urging Congress to withhold action on the Vinson bill pending the Commission's report to the President on June 15 outlining ways and means of utilizing farm products. If this plea is honored, Congressional observers concede, sale of

Louisville this year would be virtually impossible. The door was still open in March, however, for Senate action on the bill in the face of the Commission's request. In the first place, Secretary of Agriculture Ezra Taft Benson was reported cool to the plan, and in the second place, he rejected a proposal to transfer a government alcohol plant at Omaha to his Department on the ground it was "not needed."

Publicker Position

Thus the Publicker strategy to delay any action until after its lease expires at this time next year, though based on the possibility of reducing farm surpluses, faced defeat by the government official most concerned with reducing the surpluses, Secretary Benson. Publicker, at a Senate committee hearing early in March, made no bones about its self-interest in Louisville, but asserted there were also good reasons for defeating the Vinson bill from the standpoint of national security. Lawrence R. Brown, assistant to the Publicker president, told the committee:

"We are opposed for reasons of national defense and from considerations of self-interest, entirely proper self-interest, we believe. Publicker has a lease on the Louis-ville plant which extends until April, 1958, and as the tenants in the plant, and incidentally the only company that has ever operated Louisville on a commercial basis, we have added greatly to its value. Further, we have a substantial investment in the

His attack on the Vinson proposal was based on four main points, chief among

¹ RUBBER WORLD, Mar., 1957, p. 911.



The Subject of Much Controversy—the Louisville Alcohol-Butadiene Plant

them the argument that the plant still had a major defense value as an alcohol-butadiene production facility, and the Vinson-FFC attempt to sell it for general chemical manufacture would be harmful to the nation's military readiness. The bill's proponents, however, contended that Louisville's butadiene potential was no longer vital and charged that Publicker was trying to torpedo a sale under FFC management because it would have a better advantage to purchase the plant under a General Services Administration disposal program (GSA automatically inherits title to Louisville if it is not sold before the Publicker lease expires).

Nevertheless. Brown presented these "four main points" to the Banking unit:

"1. Nothing can be done under this bill that cannot be done under existing law. Without any new legislation the plant can be sold by General Services Administration with whatever security clause the Secretary of Defense deems wise. In no event, whether under present law or under this bill, can possession be taken before April. 1958. Under either present law or this bill a sale can be effectually made before that date, if it is desirable to do so. The bill is, therefore, completely unnecessary.

"2. The bill forecloses the possibility of using the Louisville plant to reduce agricultural surpluses. As long as this plant is

ready to operate as an alcohol-butadiene producer, the government can, if it will, convert unmarketable surplus grain, for which it has already paid, into stockpile rubber for which the government must otherwise continue to pay out additional money. Operated in this fashion, Louisville could be a stabilizing factor for the grain market, while saving money for the Treasury.

ury.

"3. The bill ostensibly considers national defense. Actually it completely ignores the national defense interests. What appears in the bill to be a national defense consideration—the so-called security clause—on close inspection turns out to be gross favoritism to a huge chemical combine and discrimination against any small or independent buyer [here he refers to the plan to open the bidding to any manufacturer of one or more of some 70 chemicals important to national security]. The bill is, therefore, undesirable.

"4. The bill scraps the government's \$40-million defense investment in this plant in return for no guarantee at all of any improved cash realization by the government. Furthermore, it strips the Secretary of Defense of a discretion he has under existing law, namely, to specify the type of security clause desirable in the light of the world rubber and petroleum situation a year hence."

Brown hit again and again at the testimony of government officials that Louisville was no longer vital to butadiene production because of heavy expansion in plant facilities to produce butadiene based on petroleum butylenes and butane gas. These materials also form the feedstocks for a key ingredient of high-octane aviation and motor vehicle gasoline—alkylate.

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"As an indispensable raw material for high octane gasoline, in times of war or crises of national defense." Brown argued, "butylene always has been and, in all likelihood, again will be taken away from butadiene production and assigned to military gasoline, both air and ground. This fact, not the total butadiene capacity of the petroleum industry, reveals the defense importance of the Louisville plant and the reason why the present type of security clause (requiring availability of the plant for butadiene production for ten years after sale) should not be weakened.

"No testimony on this point was presented before the House Armed Services Committee. The House report mentions the names of companies expanding butadiene production from butane (rather than butlene) but does not give any quantities. The most recent quantitative figure, according to government sources, show that upon completion of all scheduled expansion of butadiene at the end of 1958, there will be

636,000 tons of butadiene capacity still dependent upon butylene and only 302,000 tons available from butane.

"Roughly, two-thirds of the nation's synthetic rubber still will be competing for raw materials with high-octane gasoline. In contrast, Louisville operates on alcohol which can be made from constantly replenished agricultural raw materials. It is thus a secure base for wartime industrial requirement, being always available as needed."

FFC Still Supports Vinson

The Administration, led in its anxiety to sell Louisville quickly by FFC Administrator Laurence B. Robbins, had this to say to the Senate Committee through him: (1) the plant is not operating, and there is "no reasonable likelihood" that it will be operated over the next year, with the government paying almost \$350,000 annually while it is in standby; (2) the Office of Defense Mobilization has found the plant no longer needed for synthetic rubber; (3) existing law prohibits sale until after April, 1958, but "legislation is necessary to remove this prohibition and permit a prompt sale; and (4) the Vinson bill would grant the necessary new authority to proceed with disposal this year.

"If this bill becomes law in the very near future," Robbins testified, "the plant can be sold without delay, subject to the existing lease with Publicker, and the purchaser will have time to make engineering and other plans and to put them into effect promptly after taking possession of the

plant on April 4, 1958.

"The Corporation has received a sizable number of expressions of interest from companies other than those which have previously filed bids, and is convinced that a favorable market now exists. If sale of the plant is deferred, such interest can very well diminish. It seems certain that the Vinson bill will result in a greater number of bids than those submitted (last year) under the more rigid Disposal Act of 1953, and it is logical to believe that the government can secure a price not only better than the previous bids, but also better now than at some indefinite future date."

Akron Labs Disposal Now Unlikely Until Summer

The Akron rubber laboratories disposal program, which had proceeded without hitch under the experienced hand of the General Services Administration, finally ran into one in March. GSA headquarters rejected a proposed invitation-to-the-public plan of its regional office in Chicago and asked the Chicago people to resubmit a plan with certain revisions. As a result of the delay directly attributable to the rejection, plus general delays because of press of business in Chicago, the key date for a decision on whether the government will sell Akron has been pushed toward the middle of the year.

Washington spokesmen for the agency pointed out that the laboratory-pilot plant facilities so long associated with synthetic rubber research are not in a "rush" disposal category, by any means, and estimated it would be some time this month before an invitation is issued to the public and some time in May before return bids are opened. After the bid opening, GSA has allowed itself another 60-day period to negotiate with prospective buyers.

If negotiations are successful to the point where GSA thinks a sale would be worthwhile, it will turn the entire matter over to the Bureau of the Budget for a final decision. The Budget Bureau must weigh the best private offer against "bids" made by several government agencies before the end of last year. The best of these came from

the Department of Agriculture, which wants the research facilities to build up its program for finding more and better uses for farm products.

If the public bidding, however, brings an offer attractive enough to warrant disposal of Akron in favor of new research facilities for the Agriculture research program, the Budget Bureau would give the go-ahead to GSA on sale to the non-government bidder. It will be at least mid-summer before this decision is made, it was predicted by GSA sources.

Federal Court Dismisses FTC's Suits against Tire Industry on Quantity-Limit Rule Discounts

The United States Court of Appeals for the District of Columbia has thrown out the long-pending federal suits against 20 manufacturers and marketers of tires and tubes, including most of the country's major producers, after ruling that the government was wrong in setting a ceiling on quantity discounts at 20,000 pounds (a railway carload).

Technicality Involved

The Court's action, a major victory for the private firms involved, was based on a technicality which can be overcome by the government by authorizing the Federal Trade Commission to conduct a new study of conditions in the industry. Under the Robinson-Patman Act the Commission had found that "available purchasers in greater quantities (than 20,000 pounds) are so few as to render differentials on account thereof unjustly discriminatory or promotive of monopoly. . . ." Its finding, however, was not worded in terms of how many purchasers by the carload, but, rather, how many tire and tube purchasers have annual dollar volumes greater than \$600,000.

"Instead of dealing directly with the question (of carload purchasers) in its findings," the Court pointed out, "the Commission seems to have been primarily concerned with the fewness of available purchasers in annual dollar volumes greater than \$600,000. Obviously, a finding concerning that does not support a rule fixing a quantity limit of one 20,000-pound car-

load."

The three-man Court threw out tire discount suits of the Federal Government against The B. F. Goodrich Co., The General Tire & Rubber Co., Goodyear Tire & Rubber Co., Firestone Tire & Rubber Co., Allied Tire & Battery, United States Rubber Co., Inland Rubber Corp., Pacific Tire & Rubber Co., Denman Rubber Mfg. Co., Mansfield Tire & Rubber Co., Carlisle Corp., Durkee-Atwood Co., Seiberling Rubber Co., Dunlop Tire & Rubber Corp., Missouri Farmers Assn., Western Auto, Montgomery Ward, Dayton Rubber Co., Lee Rubber & Tire Corp., and American Oil Co.

Future Actions Possible

The decision, upholding an earlier one of the U. S. District Court here, leaves three courses of action to the FTC and the Department of Justice: (1) the whole thing can be dropped; (2) the Appeals Court rul-

ing can be appealed to the Supreme Court; or (3) FTC can restudy the discount situation in the light of the ruling that its earlier finding was outside the language of the Robinson-Patman Act.

Section 2(a) of the Act provides that "the Federal Trade Commission may . . . fix and establish quantity limits . . . as to particular commodities or classes of commodities, where it finds that available purchasers in greater quantities are so few as to render differentials on account thereof unjustly discriminatory or promotive of monopoly in any line of commerce. . . ."

Based on this language, the Commission issued a quantity-limit rule reading: "The quantity limit as to replacement tires and tubes made of natural or synthetic rubber for use on motor vehicles as a class of commodity is twenty thousand (20,000) pounds ordered at one time for delivery at one

time.'

As a basis for the rule, the Commission made three formal findings, none of which dealt directly with the question of the number of purchasers able to purchase tires and tubes in carload lots. Appended to the rule, however, was a "Statement of Basis and Purpose," which was in the nature of an opinion concerning tire pricing practices and which the Commission argued was worded to fill the requirement for a finding as to the number of large-quantity buyers.

"Assuming, without deciding, that the 'Statement' can be construed as indicating a finding of the sort necessary to support the rule," the Court said, "we hold it may not be used to supplement the formal find-

ings in the manner suggested.

"It may be that, had the Commission not made any specific separate findings labeled as such, it could have supported the order by writing an opinion embodying the requisite finding of fact. But, when it made formal findings in separate numbered paragraphs and said it was basing its order upon them, the order must stand or fall on the basis of those findings alone. . . .

"The Commission chose to make a finding concerning the paucity of available purchasers in quantities greater than a certain annual dollar volume, and then fixed a quantity limit in terms of a carload. Even though the Commission's accompanying statement may have indicated its belief that available buyers in quantities greater than a carload are so few as to give it authority under the quantity-limit proviso (which appellees seriously question), the Commission did not purport to base its order on that belief. We find no satisfactory explana-

tion of its failure to do so.

When a statute provides, as this one does, that a specified finding is a prerequisite to the exercise of power, and where formal findings are made which are said to be the basis of the power claimed, there is no justification for reliance on a later statement to support the exercise of the power.

Since the Appeals Court specifically refused to rule on the merits of the quantitydiscount rule itself, the door was left open for a further government attempt to jus-

FTC Hearings on TBA Sales Delayed; Scope Broadened

The Federal Trade Commission's dragged-out investigation of TBA marketing (tires, batteries, and accessories) was stalled again in March when the Commission trial officer, Edgar Kolb, conducting each of three complaints against six rubber and oil companies, was forced to set aside all hearing activity until he returns from his business trip to the West Coast toward

the end of spring.

First anniversary of these major challenges to the widespread practice of marketing TBA items through oil companies was January, and the occasion was celebrated by a Commission ruling that its complaints against half a dozen major firms were broad enough to include the relation of these companies to several dozen other companies in the sale of TBA items. As a result of this ruling, company attorneys warned that adjudication of the complaints would run far beyond the most pessimistic estimates on when the Commission might hand down its decision in one or all of the three cases.

Left hanging-subject to 10 days' notice from Examiner Kolb on resumption of hearings-were the complaints against these pairs of defendants: The B. F. Goodrich Co. and The Texas Co.: Goodyear Tire & Rubber Co. and Atlantic Refining Co.; and Firestone Tire & Rubber Co. and Shell Oil Co. All have been accused of violating the Federal Trade Commission Act by the payment of "overriding commissions" on the sale of TBA items manufactured by the rubber companies through retail gasoline outlets selling the petroleum products of the oil companies.

The oil firms collect a commission of

usually about 5% for what they insist are normal promotional activities in the sale of the rubber company products. A different battery of federal lawyers in each case is trying to show that the oil companies allegedly perform negligible sales activities and, regardless of the extent of these efforts, have purportedly frozen out other competitors who might otherwise market their TBA commodities through the same gasoline dealers.

The first important procedural fight between the government and defendant attorneys was won by the government when the Commission overruled a ruling of Examiner Kolb and ordered the defendants to be prepared to defend all of their TBA contracts, not only those of the firms with whom they are paired in the complaints. Examiner Kolb had ruled that the only relevant evidence in this area outside of all details of the relation between the defendants in each case was the simple showing that other TBA contracts existed. The Commission's overruling, however, permits its attorneys to challenge all TBA activities of the defendants and introduce any evidence on these activities. The effect of the Commission order was to bring into the proceedings several dozen companies who were not named in the complaints.

Hearings in each of the three cases have started, and when they are completed. Examiner Kolb will issue a recommended decision in each to the Commission. It will be up to the Commission to adopt or reject some or all of his recommendations and to decide whether to hand down one overall or three separate decisions covering the "overriding commission" system.

low wage rates prevailing in the United Kingdom, Japan, Hong Hong, and other

big footwear-producing areas.

Federal law provides for special tariff barriers to imports threatening industries vital to national defense, and it is the rubber footwear's contribution to the military posture which is most emphasized by industry spokesmen. RMA President Ross R. Ormsby, who opened the exhibit here, also emphasized that the industry must employ a high proportion of skilled hand labor to manufacture footwear that has as many as 86 different parts in each piece.

"This high ratio of skilled labor costs makes the industry particularly vulnerable in the competitive marketplace to cheap labor imports from the Orient and else-

where," he declared.

"The men and women who make American rubber footwear earn from three to ten times the wages paid their counterparts abroad. This means that imports can come into the American market at prices with which the domestic manufacturers cannot compete. There is not much difference in the methods of production here and abroad. The art of making rubber footwear is essentially hand labor, representing over 50% of the total cost.

"In the early Thirties, the American rubber footwear industry was seriously injured by a flood of cheap imports. After an investigation by the Tariff Commission, President Hoover put the industry under the protection of the American selling price principle. In 1937, President Roosevelt reaffirmed his action. Since World War II, this protection has been reduced substantially, both through direct tariff cuts and through administrative rulings, and the industry again is faced with destructive competition from low-wage producers abroad.

"We hope through this exhibit to impress on our Congressmen and on responsible government officials that the rubber footwear industry is essential to the country's welfare and defense, and that it needs, and should be given, adequate tariff pro-

tection.

The domestic rubber footwear industry has an annual average production valued at more than \$200 million a year, operates some 50 plants in 13 states, and employs more than 22,000 persons. Annual production runs more than 80 million pairs of footwear, involving 900 types and 9,000 styles and sizes and approximately 1,200,-000 pairs of lasts. Types run the gamut from high-styled ladies' beach and play shoes to the "prize" insulated combat boot developed during the Korean War.

RMA Campaigns for Tariff Protection for Footwear

Continues Opposition to Robinson-Patman Act Change

Domestic rubber manufacturing interests. as represented here by The Rubber Manufacturers Association, Inc., moved in March to bolster their influence with Congress against American membership in the Organization for Trade Cooperation and, at the same time, to work up new support for a bill designed to raise trade barriers against foreign rubber footwear entering the U.S. via a loophole in the tariff laws.

RMA entertained a host of Congressional dignitaries and their assistants at a combination exhibit-party displaying products of the footwear industry and imported products with which this industry is competing. The exhibit was put together to point up "the need for tariffs adequate to preserve a competitive balance between the American rubber footwear industry's 22,-000 skilled production employes and lowwage scale producers abroad," RMA said.

Footwear Industry Threatened

Immediate goals of the RMA and its Rubber Footwear Division are: (1) rejection by Congress of U.S. membership in the OTC, the proposed international agency for administration of the 35-nation General Agreement on Tariffs and Trade; and (2) Congressional approval of the Sadlak bill imposing the high rubber footwear duties in effect against footwear entering the U.S. under the lower leather footwear levies because they have a piece of leather somewhere in the top, for example, in the tongue. The bill was introduced by Rep. Antoni N. Sadlak, Connecticut Republican.

Just as important is the industry's intention to hold on to the tariff protection it already has and to increase this protection in the face of a purportedly growing threat from low-cost competition, chiefly based on

Against Robinson-Patman Change

RMA also complained in March against a major piece of legislation which almost slipped through Congress last summer under cover of virtual anonymity, but which has run into enlightened opposition this year from many important segments of the economy, including the rubber industry. This is Senate Bill 11,2 which would limit the "good faith" defense to suits charging private firms with price discrimination in the sale of their products to various dealers. The defense is a key provision of the Robinson-Patman Act which is de-

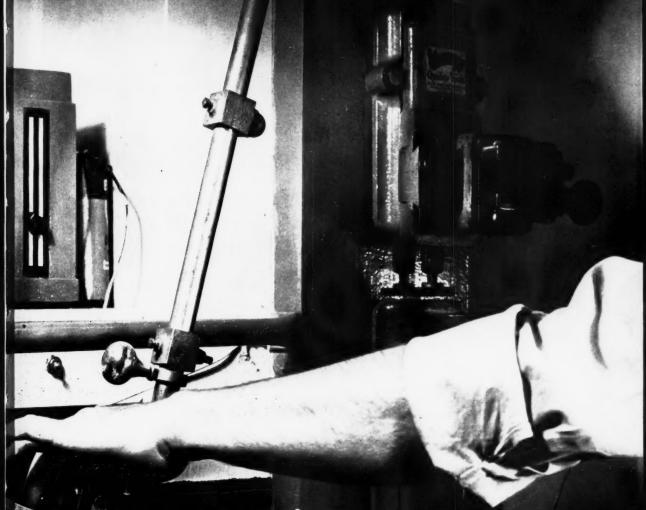
² Ibid., p. 915.





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signed to regulate marketing. If a seller lowers his price to, say, a dealer with the "good faith" reason for meeting a low price offered the same dealer by a competitor, he has recourse to the good faith defense in answering any lawsuit which may be brought against him.

Repeal of the good faith defense, RMA official, W. James Sears, told a Senate monopoly subcommittee, would "destroy the freedom to compete effectively and curtail the opportunity of our many smaller manufacturers to expand their sales in an ever-increasing market for rubber prod-

ucts." Under S. 11, he complained, a rubber manufacturer trying to meet the low-price competition of a company invading a particular market would have one of three choices, all disastrous: (1) he could meet the lower price and risk treble damage suits and government prosecution; (2) he could cut his price to all his customers in the area, which could be ruinous; or (3) he could let the invader take the dealer without a fight.

Mounting opposition to S. 11 during March considerably weakened its chances of the easy passage it almost got last year.

drop sharply. It was conjectured that Mitsui either lowered its rates for shipments to the U. S. or agreed to pay the Thailand agents a commission higher than the 5% paid by the American lines.

After the rate war began in the Fall of 1953, four European steamship companies, Hoegh Lines, Holland America, Rotterdam Lloyd, and S. M. Nederland, pulled out of the conference controlling rate levels and fought to regain the cargo the Japanese line had attracted to its own ships.

In order to end this rate war and keep it from spreading to other Far Eastern rubber ports. Fennessey said, a meeting was held in London at which Mitsui, Hoegh, and three Dutch lines agreed to join the rate conference and adhere to an agreement generally pooling Thailand rubber cargoes on a basis consistent with the number of vessels serving Thailand under each of the company banners.

Pooling Agreement Averts Rubber Freight Rate War Among American and Foreign Steamship Lines

An executive of one of the world's largest rubber carriers told the Federal Maritime Board in March that the steamship industry narrowly averted a rate war in the movement of rubber from the Far East to the United States and European markets. He hinted that such a rate war would break out unless the Board approves a rubber cargo pooling agreement between three American steamship companies and several foreign lines covering rubber shipments from Thailand.

Pooling Outlawed

The pooling agreement covers Thailand only, but Kenneth H. Fennessey, vice president of American President Lines, Ltd., said it has been effective in preventing the spread of rate war conditions to other ruber areas of Malaya, Indonesia, Indo-China, and Ceylon. APL and Lykes Brothers Steamship Co., both subsidized by the Federal Government, were "called on the carpet" to explain their participation in an arrangement outlawed by the government except for extraordinary reasons. The other American company signatory to the agreement is Isthmian Steamship Co., which is an unsubsidized subsidiary of the United

States Steel Corporation.

Fennessey also furnished the Board with some interesting figures on imports of Far East rubber into U. S. Atlantic and Gulf Coast ports, on regularly scheduled "liner" vessels since 1952. His data showed there has been an almost steady decline in natural rubber imports over that four-year period. Such imports in 1952 from Thailand, Malaya, Indonesia, and Indo-China amounted to 625,508 long tons on regularly scheduled vessels. There was a sharp drop to 522,960 tons in 1954, a slight recovery to 553,662 tons in 1955, then an indicated drop of 75,000 tons during 1956 to about 478,000 tons.

Mitsui Line Problem

Fennessey told Board Trial Examiner C. B. Gray that the pool arrangement was the only way to stop a rate war which began several years ago when the Japanese Mitsui Line reentered the trade for the first time since before World War II. The three American lines already active in moving rubber from Thailand were carrying over half the rubber and latex to the U. S., but with Mitsui's reentry into the business, the American share of the business began to

Present Arrangement

Under present sailing schedules, the American trio gets 34.5% of the Thailand-U. S. rubber shipments, or just under its total of 37% of the sailings. Completion of the pool agreement brought two sharp rate increases totaling \$9.50 per ton, from \$35.50 to \$45 in successive steps. Under conference rules all lines must charge the same rate and pay the same commissions, regardless of their costs. In the case of APL. Fennessey said the rate increases did not fully reflect increases in operating costs.

The real importance to his line and the other American lines, he indicated, was the pooling agreement's stabilizing effect in the face of a rate war "which would certainly have spread" to other rubber producing areas in Southeast Asia.

Continued participation of APL and Lykes in the Thailand rubber pool is dependent upon a decision of the Federal Maritime Board, expected to be favorable to the steamship lines in view of previous FMB approval of similar agreements in other cases.

National News

Humphreys Decries Big Government and Return to Taxing and Spending Policies of Past

H. E. Humphreys Jr., president of United States Rubber Co., in a talk at the annual meeting of Associated Business Publications in New York, N. Y., March 7, decried the Federal Government's recent reversion to the taxing and spending philosophy and policies of the past. It means that big government with its excessive spending, huge national debt, inflation, runaway welfare plans, threatened

controls and progress-stifling, back-breaking tax load is still with us, he added.

He called on business publications to help business carry the story to the people so that they "will rise up and insist our government recognize the folly of its taxing and spending policies."

"I believe in the right of the American people to have as much government as the majority wants. But I also believe they have the right to know what they are letting themselves in for." Humphreys declared.

"I do not question the sincerity or integrity of our leaders in Washingon, but I am convinced that the average citizen has no idea who pays for big government and how much. And the government has not taken much pains to tell him.

"There is one important truth that people just don't seem to understand. It is this: The government produces nothing. Whatever it spends for people, it must take from people in taxes. . . Furthermore, the government takes from the same people it gives to. Corporations can't pay taxes. Neither can stores or garages or hotels or laundries or anyone else who is in business. They can only collect taxes. Only people can pay taxes. And the 'little' people pay most of them. There is no way to avoid it.

"I believe that a failure to understand this basic truth—that the government can give only what it takes away—today threatens our future economic progress—

in fact our way of life.

"The government sets a good table. The food looks good, and the supply often seems unlimited. But let's exercise restraint and push ourselves away before we get economic indigestion."

Humphreys said also business was not blameless in that it, too, keeps trying to grind its own ax in Washington. It would like government to set minimum prices when competition gets tough and settle labor disputes. When businessmen start to join in the government game of give and take, it is high time that they stop and take a careful look at what the game is getting them into, and all Americans with them, he stated.

"Neither business nor business publications exist except to serve the individual. Business is made up of people—people who invest savings, who supply materials, people who produce goods and people who buy them. A corporation is no more than an agent to fulfill the needs and

wants of these people."

Five Policies To Consider

Humphreys further declared that we need to focus the spotlight on how the average individual is affected by the government's game of give and take and mentioned five things the government is doing to the individual.

First. The genesis of our trouble today is excessive government spending. The \$71.9-billion budget for fiscal 1958 is \$3 billion greater than the estimated spending in fiscal 1957, and \$5.3 billion above the amount actually spent in fiscal 1956. It sets an all-time high peacetime record and comes to \$1,356 for each American family.

Second. The overhanging national debt at the end of fiscal 1956 stood at \$273 billion-or \$5,130 per family. We are paying more than 10% of our federal income for interest on the debt. If any corporation paid such a large share of its income for interest on its debt, we would consider it a very unsound financial position, it was said.

Third. Inflation, resulting from government's unsound spending policies, eats away at people's buying power and their confidence in the future of business and

of the government.

Fourth. The amount asked for labor and welfare programs in the new budget is \$14 billion, as compared with \$8 billion four years ago and \$3 billion 10 years ago. To give \$14 billion for security, the government will have to take an average of \$200 from each wageearner's pay.

Fifth. We hear once again the threat of government controls-price controls, wage controls, credit controls. Controls through competitive forces out of balance open the door to black markets, lead to scarcities and surpluses on store shelves, and, in the end, waste the purchasing power of the consumer's dollar.

Tax Cut Needed

Humphreys said that of all the difficulties with the present governmental fiscal and economic policies the most important was the back-breaking tax load. The worst thing about the personal income tax was considered to be the steep graduation which leaves little incentive for a man to strive to earn more than

\$25,000 a year. This penalty on progressiveness kills incentive in management and thereby drains away the very life blood of our economic progress, he added.

The present corporate income tax rate of 52% of net income above \$25,000 tends to encourage corporate wastefulness, and the consumer pays the full amount of higher corporation expenses-tax and all-in the form of higher prices. Corporation taxes penalize success because they penalize the individual consumer by preventing him from enjoying the price benefits that come from efficient, largescale production.

It was emphasized in conclusion that unless the American people rise up and insist that our government recognize the folly of its taxing and spending policies, we shall soon find ourselves at a fateful turning point. It will be a point at which we shall turn away from free opportunity and a rising standard of living and toward economic decline and a welfare state.

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Chemical and Rubber Product Industries Production, Sales and Inventories Surveyed

Table 1. % Change in Production by Calendar Quarters—All Manufacturing, Chemical, and Rubber Products, 1955-57*

		ufacturing nge from	Chemical % Char	Products age from	Rubber Products % Change from		
Period	Preceding Quarter	Quarter a Year Ago	Preceding Quarter	Quarter a Year Ago	Preceding Quarter	Quarter a Year Ago	
1955 1st quarter 2nd quarter 3rd quarter 4th quarter	uarter +4.5 +12.0 uarter +1.4 +13.6		+3.9 +5.7 +1.8 +1.8	+ 9.0 +13.6 +14.1 +13.8	+10.2 + 5.0 - 5.4 + 5.0	+25.0 +25.6 +33.7 +15.0	
1956 1st quarter 2nd quarter 3rd quarter 4th quarter	$ \begin{array}{r} -0.7 \\ -0.7 \\ 0.0 \\ +3.5 \end{array} $	+ 7.5 + 2.1 + 0.7 + 2.1	$^{+0.6}_{+2.3}$ $^{-0.6}_{0.0}$	+10.1 + 6.6 + 4.1 + 2.3	- 3.4 - 7.8 + 1.5 + 4.7	+ 0.7 -11.6 - 7.9 - 8.2	
1957 1st quarter†	+1.4	+ 4.2	+2.3	+ 4.0	+ 3.0	- 2.1	

*Based on the seasonally adjusted indices of the Federal Reserve Board (1947-49=100), which for the first quarter of 1955 averaged as follows: all manufacturing, 134; chemical products, 158; and rubber products, 140.

†Estimated in whole or in part by the Chemical & Rubber Division, BDSA.

Growth and changes in production, sales, and inventories for the chemical and rubber products industries for 1955, 1956, and an estimate for the first quarter of 1957 were presented in the February issue of the Commerce Department's monthly publication, "Industry Report—Chemical and Rubber."

Production

It was pointed out that the shortterm rate of production growth in the chemical and allied products industry slowed its tempo in mid-1956 as compared with the 1955 upswing. Although chemical production as a whole attained record heights in 1956, the volume of average quarterly output remained fairly stable

after mid-year (see Table 1).

A continued and sustained upswing in 1957 in the physical volume of chemical goods produced will result largely from the interplay of a series of factors. These include output from new plants scheduled to come on stream this year; increased diversification of products to avoid seasonal slack periods; peak capacity operation and increased productivity to reduce unit costs and gain a better competitive position; servicing the expanding needs of a rapidly growing population with an advancing standard of living; heavy governmental spending; and expanded consumer spending.

While not all segments and products in the chemical field will participate in the increased output in 1957, the industry as a whole is expected to show an upward trend, it was said.

The rate of production growth in the rubber products industry has been consistently substantial over the long term, but short-term performance has been erratic, sometimes marked by large up-anddown swings, according to the Commerce Department report.

Replacement shipments of tires have risen roughly as the number of rubbertired vehicles has increased, although recessions, war restrictions, and scare buying have distorted the trend at times, it was said. Original-equipment tire demand, along with demand for the hundreds of other rubber items which now use almost as much new rubber as tires, usually determines the short-term production course and is dependent to a large extent on motor-vehicle production.

With the record output of automobiles supplying the impetus, 1955 volume of rubber products reached new heights, and when automobile production slowed down in 1956, output of rubber products followed the same trend. Expected improvement in automobile output in 1957 should mean increased rubber products output close to the record 1955 level, but, on basis of current indications, probably will not equal it.

Sales and Inventories

The picture with respect to the shortterm growth rate of chemical manufacturers sales is somewhat complicated by

94

a dollar measurement subject to wholesale price changes.

The new chemical sales record of about \$24.3 billion for 1956 is expected to climb to approximately \$25.7 billion in 1957; a good part of the increase, however, is attributable to rising prices.

The value of chemical manufacturers' inventories is currently at the highest level in the history of the industry (about \$3.7 billion, unadjusted for seasonal variation) and is scheduled to move moderately higher in 1957.

The stock-sales ratio for chemicals in the past three years has varied from 2:1 in February, 1954, to 1.5:1 in early and late 1955. In 1956 the range extended from 1.7: and 1.9:1, with the year ending at 1.8:1. With sales in early 1957 expected to increase at a faster rate than inventories, the stock-sales ratio is expected to drop to about 1.7:1.

Manufacturers' sales of rubber products in 1957 should follow a course parallel to that of production, showing an increase over 1956 volume, it was said. Estimated at \$5,413 million, 1956 sales showed a small decline of 1.3% from the 1955 total of \$5,484 million. With the physical volume of output expected to exceed 1956, and prices on the uptrend, the 1957 value of sales probably will surpass the 1955 high, it was pointed out.

The volume and the value of rubber products manufacturers' inventories were extremely high in the first half of 1956; value exceeded \$1 billion for the first time. From midyear on, inventories were reduced, but the high level of activity, along with higher prices, means that the value on inventories will probably remain at a high level in the immediate future.

The monthly stock-sales ratio for rubber products ranged between 2.1 and 2.5 in easy 1954, between 1.7 and 2.1 in active 1955, and between 2.1 and 2.4 in the first nine months of 1956. Since sales are expected to increase in 1957, the ratio seems likely to average around the 2.0 level, the Commerce Department Business & Defense Services Administration's report concluded.

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Labor Pot Simmers

Policy on 1957 wage increases for coming negotiations with the industry were drafted by the international policy committee of the United Rubber Workers of America, AFL-CIO, at a meeting in Philadelphia, Pa., March 22-23.

In wage negotiations last year the URWA won a 9.2¢-an-hour increase for its members, of which 6.2¢ was on general wage scales and 3¢ was earmarked for the start of a supplemental unemployment benefit fund.

Actually, wage increase negotiations for 1957 have already started between United States Rubber Co. and the URWA, and other companies are expected to receive requests from the union for such talks in the near future.

With the present company-wide contract on working conditions between The B. F. Goodrich Co. and the URWA ending on April 1, the company and the union began new contract talks in early March. Wages were not up for discussion in these talks.

Table 2. % Change in Manufacturers' Sales by Calendar Quarter for All Manufacturing Industries, Chemical and Allied Products, and Rubber Products, 1955-57*

		ufacturing nge from	Chemical % Char	Rubber Products % Change from				
Period	Preceding Quarter	Quarter a Year Ago	Preceding Quarter	Quarter a Year Ago	Preceding Quarter	Quarter a Year Ago		
1955 1st quarter 2nd quarter 3rd quarter 4th quarter	+5.2 +6.4 -0.5 +3.1	+ 6.9 +13.7 +16.2 +14.8	+10.7 + 7.3 - 2.4 - 0.6	+15.4 +20.9 +19.9 +15.1	$^{+16.0}_{+\ 5.9}_{-\ 2.3}_{0.0}$	+21.4 +19.9 +26.9 +19.9		
1956 1st quarter 2nd quarter 3rd quarter 4th quarter†	$ \begin{array}{r} -0.8 \\ +1.9 \\ -3.9 \\ +9.9 \end{array} $	+ 8.2 + 3.6 + 0.1 + 6.7	+ 2.8 + 3.9 - 2.4 + 3.7	+ 6.9 + 3.5 + 3.5 + 8.0	- 4.8 + 6.2 - 5.4 + 6.6	$ \begin{array}{r} -1.6 \\ -1.3 \\ -4.4 \\ +2.0 \end{array} $		
1957 1st quarter†	+1.0	+ 8.7	+ 1.2	+ 6.4	+ 7.1	+14.7		

*Based on unadjusted sales of the Office of Business Economics of the Department of Commerce which averaged as follows for the first quarter of 1955 (millions of dollars): all manufacturing, \$25,073; chemical products, \$1,846; and rubber products, \$443.
†Estimated in whole or in part by the Chemical & Rubber Division, BDSA.

Other Industry News

Building Cab-O-Sil Plant

Cabot Carbon Co., subsidiary of Godfrey L. Cabot, Inc., Boston, Mass., will begin construction of a new plant at Tuscola, Ill., for the production of the company's silicon oxide pigment, Cab-O-Sil. The pigment is now being made for Cabot by a German firm, Degussa.

Cab-O-Sil is used in reinforcing rubbers and plastics, as a suspending agent in paints, a flatting agent in varnish, a jelling agent in lubricants, an anti-slip agent in wax and in the insulation of electrical equipment, among other uses.

The Tuscola plant, with a capacity of about 100 carloads a year, will be located on a recently purchased 75-acre tract adjoining the plant sites of U. S. Industrial Chemical Co. and National Petro-Chemical Corp. Hydrogen for the silicon oxide production will be obtained from USI, and hydrochloric acid, a by-product in the process, will be sold to National Petro-Chemical.

Marlex 50 Output Grows

The Houston, Tex, Marlex 50 plant of Phillips Chemical Co., Bartlesville, Okla., is now in large-scale commercial production of the company-developed rigid polyethylene. Production capacity is expected to reach 75 million pounds a year before the end of 1957, the company reveals.

Stronger and more resistant to temperature extremes, chemicals, and abrasion than conventional polyethylenes, Marlex 50 resin is expected to move into such growing markets as household wares, toys, packaging film, fabrics, filaments, and containers

Emery Canadian Subsidiary

Emery Industries, Inc., Cincinnati, O., has formed Emery Industries (Canada), Ltd., as a wholly owned subsidiary. The new firm has acquired the land, buildings, maufacturing facilities, and existing fatty acid business of S. F. Lawrason & Co., Ltd., London, Ont., Canada.

In addition to the Emery brands of stearic, oleic, animal, and vegetable fatty acids and glycerides, the new company will produce lard oils, metal working compounds, textile chemicals, and Sanitone dry cleaning compounds. R. T. Hull has been appointed vice president and general manager.

F. S. Lawrason & Co. will be retained as exclusive sales agent for all Emery products, except Sanitone, in the Dominion. The firm plans new quarters in London, Ont., for expanded manufacture of its sanitary and specialty chemicals, along with increased sales activities.

U. S. Rubber Cuban Plant

United States Rubber Co., New York, N. Y., has begun building a \$5,000,000 tire plant at Loma de Tierra, 15 miles east of Havana, Cuba, which will be the largest tire factory in Cuba. Operations are expected to start early next year.

The new plant will be located on a 15-acre site now partially occupied by a U. S. Rubber footwear plant. Producing about 125,000 passenger-car and truck tires a year, this new plant will consist of a single-story main building with 54,000 square feet of floor space and a two-story building with floor space totaling 25,000 square feet.

New MIL Specs, Standards Released by Ships Bureau

Two new editions of military specifications and three new editions of military standards have been announced by the Bureau of Ships, Department of the Navy,

Washington, D. C.

Military Specification MIL-H-19606 (SHIPS) of December 13, 1956, refers to hose and assemblies, synthetic rubber, reinforced, water and oil resistant, medium and high-pressure, non-magnetic and regular service. This covers water, fuel, hydraulic, pneumatic, and oil hose for shipboard use. The sizes range from 316-inch to six inches inside diameter, and the proof pressures go from 600 to 10,000 psi.

Specification MIL-F-19607 (SHIPS) of January 17, 1957, refers to fittings, hose, reusable, medium, and high pressure. This is a new specification for reusable-type hose fittings to be used in conjunction with the above described hose.

Both of these specifications contain the qualification clause that awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable qualified products list.

Three of the Bureau's visual inspection guides on various rubber products have recently become available as Military Standards. These are the following: Military Standard MIL-STD-289, Visual Inspection Guide for Rubber Sheet Material: MIL-STD-293, Visual Inspection Guide for Cellular Rubber Items; and MIL-STD-294. Visual Inspection Guide for Rubber V-Belts.

V-Belt Custom Packaging

The Dayton Rubber Co., Dayton, O., is making available to original equipment manufacturers custom designed, palletized shipments of V-belts for greater economy in handling and warehousing.

The company's packaging technicians will survey a customer's equipment and storage demands and will design an effective package. Three days after the survey the special design will be submitted for approval, and a test shipment made for the customer's inspection.

Trilok Patent Disputed

United States Rubber Co., New York, N. Y., has termed without merit the patent infringement suit involving threedimensional fabrics filed against it on February 20, 1957, in the United States Court for the Southern District of New York in Manhattan by Bates Mfg. Co.

U. S. Rubber says it has been engaged in the research and development of threedimensional fabrics since shortly after World War II. It applied for a patent on September 8, 1948. This patent was issued on August 19, 1952, and reissued on May 24, 1955.

The company's three-dimensional fabric is being marketed under the name of Trilok.

Four New Firestone Plants Are Nearing Completion

Four new manufacturing plants costing about \$30 million will be completed by The Firestone Tire & Rubber Co., Akron. O., during the next few months in what the company terms "one of the largest con-centrated building programs ever undertaken in the rubber industry.

The new plants scheduled for completion between now and October are a butadiene manufacturing plant at Orange, Tex.; a tire plant at Havana, Cuba; an air springs plant at Noblesville, Ind.; and a tire plant in Manila, Philippine Islands.

In addition, the company is going ahead with extensive expansion, modernization, and improvement plans in many of its existing plants. These plants are at Pottstown, Pa.; Lake Charles, La.; Akron, O.; Fall River, Mass.; Los Angeles, Calif.; and Des Moines, Iowa.

Improvement projects are also scheduled for Firestone plants in Brentford, England; Buenos Aires, Argentina; and Port Elizabeth, South Africa. A multi-million-dollar expansion program was recently begun at the company's Hamilton, Ont., Canada,

The expansion program will increase Firestone's capacity for production of synthetic rubber to 230,000 tons a year within the next few months, according to Harvey S. Firestone, Jr., the company's board chairman. Firestone, which has extensive holdings of natural rubber plantations in Liberia, as well as in Brazil, claims to be the world's largest producer of rubber.

The Orange, Tex., butadiene project is slated for completion this month. It will have a capacity of 40,000 tons a year.

Diamond Plans New Plant

Diamond Alkali Co., Cleveland, O., has announced plans for building a new plant to produce 50 million pounds of vinyl chloride monomer annually. The facility will be located at the company's Deer Park Plant, Houston, Tex. Completion is scheduled for early 1958.

According to A. L. Geisinger, vice president and general manager of the company's plastics division, the new monomer plant is part of a major expansion program, which will also include the construction of a plant to produce acetylene from natural gas.

IP&C (Canada) Acquires

Imperial Paper & Color Corp. (Canada), Ltd., St. Johns, P.Q., is taking over all the dry color operations of Brandram-Henderson, Ltd., Montreal, P.Q. Imperial. a subsidiary of Imperial Paper & Color Corp., Glens Falls, N. Y., will buy the dry color equipment of Brandram-Henderson, its formulae, good will, and customer

Brandram-Henderson, one of the original dry color producers in Canada, was established in 1905. Imperial Paper of Glens Falls is one of the largest pigment color manufacturers in the world.

Engineers Aver Job Status Key to Manpower Shortage

American engineers believe that the way to end the engineering manpower shortage in this country is to strengthen the status of engineers already employed.

This belief was indicated in the results of a poll published by the American Society of Mechanical Engineers, New York, N. Y. The question, "What measures do you think should be taken to end the shortage of engineering manpower?" asked of engineers attending the ASME's annual meeting in New York last No-

Of those polled 31% said they thought engineers employed in industry should be provided with more technical assistants and clerical help, thereby freeing professional men for more creative work.

Increasing salaries to make the profession more attractive to youngsters and to qualified engineers who were being lured to other fields by higher pay was suggested by 21%. Improving the recognition and prestige accorded to engineers for their contributions to the economy was recommended by 12.5%.

Other suggestions included the improvement of high school and college engineering courses and giving financial support ma

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ASME President William F. Ryan, in commenting on the results of the survey. said he personally thought the most urgent problem relating to salaries was the poor compensation engineering school teachers are receiving.

Eagle-Picher Acquires

The Eagle-Picher Co., Cincinnati, O., has purchased all of the assets, including patents, of Gora-Lee Corp., Stratford. Conn., producers of bibb washers, tack bumpers, screw washers, nail washers, O-rings, and other rubber products.

The Stratford firm also has patents on an automatic molding machine capable of producing a wide variety of high-precision molded rubber parts. Operations of Gora-Lee will become part of Eagle-Picher's The Ohio Rubber Co. Division.

Wheelabrator Wet Blasting

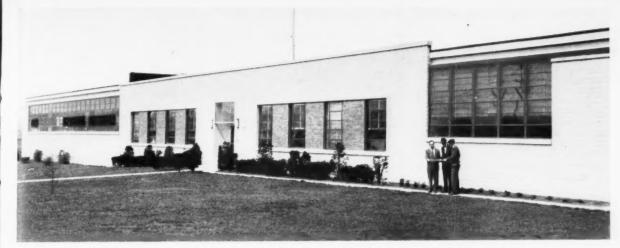
Wheelabrator Corp., Mishawaka, Ind., is using a new round-particle abrasive for wet blasting tire and other rubber molds which produce glossy surfaced consumer

Wet blasting is generally confined to molds on which finish is not important since it leaves a matte surface on a mold that imparts a similar dull surface to rubber goods. The process, however, is fast, gives a uniform finish on all areas, and eliminates manual brushing, scraping, grinding, and burning.

Although not revealing the composition of the smoother abrasive. Wheelabrator says it maintains the efficiency of the wet-blasting process while yielding glossy

surfaced goods.

RUBBER WORLD



Clifton laboratory and office building of W. R. Grace & Co.'s Polymer Chemicals Division

W. R. Grace's Polymer Division Shows New Lab Building

The recently completed laboratories and main offices of W. R. Grace & Co.'s Polymer Chemicals Division at Clifton, N. J., were officially introduced to members of the trade press in a tour of the 50.000-square-foot facility on March 7.

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The Division was organized as the seventh chemical division of W. R. Grace & Co. in March, 1956. It has ben licensed by Phillips Petroleum Co. to make high-density polyethylene at a soon-to-becompleted plant in Baton Rouge, La., which will have an annual capacity of 50 million pounds of the resin.

The Clifton plant is situated on a 150acre tract of land four miles from the petroleum refineries of Esso Standard Oil Co., which will supply the ethylene gas required for production of the resin.

According to T. T. Miller, president of the Polymer Chemicals Division, the Clifton site was chosen for the new laboratory because more than 50% of the plastics fabricators in the United States are located within a radius of 300 miles.

The Division will market its high-density polyethylene under the trade mark Grex 100. The resin is said to have a tensile strength of 5,100 psi. on annealed compression-molded samples, an Izod impact strength in excess of three footpounds per inch, greater heat and cold resistance than conventional polyethylene, and improved versatility in film or laminations.

Addressing a luncheon meeting on the growth of the plastics industry, Gen. J. E. Hull, president of the Manufacturing Chemists' Association, noted that production of plastics and resins was four billion pounds during 1956, over 15 times the 1940 total and 75 times the 1922 total.

mers for the synthetic fiber and film industry, alkyd resins for the paint industry, plasticizers, and dyestuffs. They will be made by what Amoco calls a "unique" hydrocarbon oxidation process.

The raw material used for the process, mixed xylenes, will be obtained from the Standard Oil Co. (Indiana) refinery at Whiting, Ind. The new process is said to enable the production of a diversified line of chemicals at a single plant from one source, using petroleum raw materials. Standard Oil, parent company of Amoco Chemicals, holds worldwide exclusive rights to the process.

Latex Unit for Polymer

Dow Corning Corp., Midland, Mich., is giving up production of Silastic Type R and RG Tape and Cloth, glass-cloth coated with semi-vulcanized silicone rubber which Dow developed and introduced.

Yields Silastic Cloth Sales

Demand for the material has become too brisk, according to C. A. Doremire, the company's manager of electrical sales, and Dow Corning has withdrawn from directto-the-customer sales in order to concentrate on the development and production of raw silicone products.

Mr. Doremire said the company was encouraging the manufacture of the cloth by other competent firms. These currently include Continental Diamond Fibre Division. Budd Co., Inc., Valparaiso, Ind.; Permacel Tape Corp., New Brunswick, N. J.; and Quaker Rubber Division, H. K. Porter Co., Philadelphia, Pa.

Originally designed as a resilient, hightemperature cure-in-place insulation for motor coils, Silastic Type R and RG Tape and Cloth is now being used as flexible heating elements, curing blankets, and aircraft hose and tubing. Polymer Corp., Ltd., Sarnia, Ont., Canada, is building a new specialty latex plant to the north of its existing copolymer unit tank farm area which is expected to be in operation by the end of the year. To cost about one million dollars, the plant will provide separate facilities for handling, treating, storing, and loading rubber latex.

The expanding demand for latex foam products in Canada prompted the building of the new plant, the company says.

Amoco Building New Plant

Amoco Chemicals Corp., Chicago, Ill., is building a new plant near Joliet, Ill., which will produce 60 million pounds annually of phthalic anhydride, isophthalic acid, terephthalic acid, dimethyl terephthalate, dimethyl isophthalate, and benzoic acid

These products are chemical intermediates used in the manufacturing of poly-

Seiberling Dealers' Plan

Seiberling Rubber Co., Akron, O., is providing through its independent dealers 14-inch-diameter wheels and tires for most makes of 1956, 1955, and 1954 cars now equipped with 15-inch wheels.

The National Wheel & Rim Association recently announced that its member distributors could provide the 14-inch wheels for the older model cars. Seiberling dealers are getting the smaller-diameter wheels and wheel covers from local distributors belonging to the Association and the tires from Seiberling.

More C&C Acrylonitrile

Carbide & Carbon Chemicals Co., division of Union Carbide & Carbon Corp., New York, N. Y., will double production of acrylonitrile at its Institute, W. Va., plant by the second quarter of 1958. Higher demand for acrylic fibers, high impact resins, nitrile rubber, and new acrylonitrile derivatives was given as the reason for the increase.

Recent developments cited by the company are new thermoplastic terpolymers, made from acrylonitrile, butadiene, and styrene, which have high impact and high distortion strength; and dimethylamino propylamine and diethylamino propylamine, used in the manufacture of textile softeners.

Goodyear Cylinders Cushion Fall of Equipment Air Rafts

Large bellows-like rubber cylinders produced by the aviation products division of The Goodyear Tire & Rubber Co., Akron, O., have been incorporated into the design of new heavy equipment air rafts which will accompany assaulting United States paratroopers on air drops.

The 34-inch-diameter cylinders, made of nylon fabric thinly covered with rubber, are intended to cushion the fall of the rafts in order to protect such heavy equipment as howitzers, jeeps, tractors, and graders. Collapsed before the rafts are dropped, these cylinders are inflated by uprushing air, with diaphragms controlling the escape of the air to prevent blowouts and sudden load shocks upon landing.

Produced by Brooks & Perkins, Inc., Detroit, Mich., under contract with the Wright Air Development Center, the air delivery platforms are made of lightweight magnesium. Carried on a roller-type conveyor in an airplane's cargo compartment. a loaded raft is ejected from the plane and lowered to the ground by parachutes.

The platforms are being made in 11-, 15-, and 24-foot sizes, the largest having a 20,000-pound carrying capacity, cushioned by 12 of the Goodyear cylinders. The units are recoverable.

New Monsanto, Ltd., Stock

Monsanto Chemical Co., St. Louis, Mo., has revealed that its British subsidiary, Monsanto Chemicals, Ltd., has issued additional securities for the purpose of expanding into the petrochemicals field.

Rights to subscribe to \$5,670,000 additional common stock have been issued to its common shareowners, and the American firm, which owns two-thirds of the outstanding common stock of the British company, has subscribed for its portion in the amount of \$3,780,000.

Monsanto Chemicals, Ltd., has begun work at a 100-acre site adjacent to the refinery of Esso Petroleum, Ltd., at Fawley, near Southampton, England, which will provide most of the raw materials. Among the products to be made will be polyethylene, acrylonitrile copolymers, and acrylonitrile.

Richardson-Bellows Formed

The Bellows Co., Akron, O., and Richardson Scale Co., Clifton, N. J., have formed a new company, Richardson-Bellows S. A., with headquarters in Geneva, Switzerland, for the manufacture, sale, and servicing of Bellows motors and "controlled air-power" devices and Richardson materials handling equipment, control panels, and automatic scales

The new company, which will distribute its products to Europe, portions of Africa, and the Near East bordering on the Mediterranean, will introduce "the best aspects of American technology and industry" to a European market short on dollars, I. Richardson, president of Richardson Scale, and H. B. Link, Bellows president, said in a joint statement.



Artist's conception of U. S. Air Force's new heavy equipment rafts being parachuted to ground. The eight Goodyear rubber cushioning cylinders beneath raft in foreground are inflated by uprushing air through the six-orificed diaphragm beneath each cylinder.

G-E Building Silicone Lab

Construction of a new product and process development laboratory and further expansion of other facilities of the silicone products department of General Electric Co., Waterford, N. Y., have been announced by Charles E. Reed, department general manager.

The laboratory, expected to be ready for occupancy in January, 1958, is part of a \$3 million capital outlay planned for the Waterford plant during 1957. Conceived as the first step in the creation of a silicone technical center, the twostory building will double the research space now available.

Other construction during 1957 will include a major increase in rubber compounding equipment and a boost in manufacturing facilities for various silicone intermediates. Work will also continue on the expansion of various service and utility installations.

Agree to Seiberling Slate

J. P. Seiberling, president of Seiberling Rubber Co., Akron, O., and other members of the Seiberling family have signed an agreement with Edward Lamb to vote all Seiberling common stock owned by both parties for a joint slate of directors at the company's annual meeting on

Mr. Lamb, one-time contender for control of the company, signed both as an individual shareholder and as head of Edward Lamb Enterprises, Inc., Toledo, O.

In issuing the joint statement, both parties said the agreement had been made to avoid the need of separate solicitation of proxies by the two groups, with the consequent additional expense and disruption of normal company business.

Fifteen candidates for membership on the 1957 board, all now directors, have been nominated. They are A. C. Blinn, L. B. Buckingham, P. A. Frank, C. E. Jones, Edward Lamb, J. Howard McGrath, Frank C. Oswald, H. E. Paige, M. H. Pendergast, H. P. Schrank, J. P. Seiberling, L. M. Seiberling, W. P. Seiberling, T. Tyler Sweeny, and R. J. Thomas.

Cooler Urethane Formulae

New polyester/isocyanate formulations that react at relatively low temperatures to produce foamed-in-place rigid polyurethane encasings or pottings for components of electronic equipment have been announced by The Dayton Rubber Co., Dayton, O.

The formulations react at room temperature, producing temperatures during reaction no higher than 172° F., the company reports. Conventional rigid foams produce temperatures of about 280° F. during the reaction process. The lower temperature eliminates the danger of splices and injury to delicate thermoplastic insulation.

Other advantages claimed for the new formulations are: freer flow into larger mold cavities due to an increase in setting time; precluding of problems of fissures and discoloration from excessive heat; and reduction of toxicity because less free isocyanate is vaporized into the atmosphere.

The lower temperatures are particularly vital for such sensitive electronic equipment as components for aircraft, guided missiles, and torpedoes, according to Dayton.

New Du Pont Sales Lab

Construction has begun on a fifth laboratory building at E. I. du Pont de Nemours & Co.'s center for sales service research at Chestnut Run, near Wilmington. Del. The \$5-million structure is expected to be ready for occupancy in the Spring of 1958.

To be operated jointly by the company's pigments and electrochemicals departments, the laboratory will conduct customer service and development work on titanium, silicon, pigments, sodium, peroxygen, chlorine, vinyl, and related product fields.

Providing 81,000 square feet of floor space, the laboratory will be staffed by 50 members of the electrochemicals department and by about 100 members of the pigments department.

Du Pont's Newark, N. J., color sales service laboratory will move to Chestnut Run, as will part of the Newport, Del., white pigments laboratory. The pigments area of the new laboratory will house such equipment as ball and roller mills and other facilities for incorporating pigments into rubber, plastics, paint, paper, and other products, the company says.

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Testing of new fuel cell materials and designs required for advanced military aircraft is underway in a recently completed \$500,000 laboratory at the Los Angeles, Calif., plant of The B. F. Goodrich Co.

Rubber or rubber-like materials and fuel-cell constructions that withstand both extremely hot and cold temperatures will be a major goal of the laboratory, according to P. W. Perdriau, general manager, Aviation Products, a Goodrich division.

The new laboratory features a "hot and cold room" capable of sustaining temperature ranges of —85 to 165° F. Two other cold chambers for development testing have temperature ranges down to—100° F. A sublimation chamber will be used to cool test fuel to as low as —100° F.

Final qualification tests of fuel cells for specific airplane installations include slosh strength tests, abrasion resistance, ability of the material to withstand extremely high and low temperatures, and extended stand test periods with the cell filled with fuel.

3M Buys Kel-F Business

Minnesota Mining & Mfg. Co., St. Paul, Minn., has purchased the Kel-F elastomer manufacturing business of M. W. Kellogg Co., a subsidiary of Pullman, Inc., New York, N. Y. The deal includes the assumption of ownership of Kellogg's Jersey City, N. J., Kel-F plant.

A spokesman for Kellogg said the sale would have no effect on the company's petroleum and petrochemical research laboratories and other manufacturing activ-

ities in Jersey City.

Kellogg, an international engineering and construction firm for the petroleum and petrochemical industries, originally became associated with the fluorocarbon polymer field as a result of its engineering assignment at Oak Ridge, Tenn., during World War II.

Minnesota Mining will seek to develop additional uses for Kel-F, particularly within the chemical field and for pharmaceutical packaging, it was said.

Safety Award to Firestone

The highest award of the National Safety Council has been presented to The Firestone Tire & Rubber Co., Akron, O., in recognition of the firm's safety record during 1956 in all of its 42 plants both in this country and abroad. This is the ninth such award the company has received in the past 12 years.

Firestone's worldwide accident frequency rate for 1956 was 1.20, 75% below the accident rate for the rubber industry as a whole. The company's accident severity rate was 248, 51% below the industry-wide rate. The latter is based on the number of days lost per one million

man-hours worked.

J. E. Trainer, Firestone's executive vice president, said the safety record means that the company's safety programs are saving lives just as surely as modern medicine.

Vacform Rights to Emhart

Emhart Mfg. Co., Hartford, Conn., has obtained all rights to a complete line of vacuum forming machinery formerly produced by Vacuum Forming Corp., Port Washington, N. Y. The line will be manufactured by Emhart's Henry & Wright Division. Financial details of the sale were not made available.

The machines will continue to be identified under the trade names VacForm and VacTrim. Such companies as E. I. du Pont de Nemours & Co., Inc. Dow Chemical Co., Celanese Corp. of America, Spencer Chemical Co., and Naugatuck Chemical Division of United States Rubber Co. are using VacForm machines in product research and manufacturing operations, according to Emhart.

Gates Gets Gas Turbine

The rubber industry's first gas turbine has been placed in operation at Gates Rubber Co., Denver, Colo., according to General Electric Co., Schenectady, N. Y., whose gas turbine department manufactured the 5,000-kilowatt gas turbine-generator unit.

A simple-cycle, single-shaft gas turbine designed for dual-fuel operation burning natural gas or distillate oil, the unit furnishes the plant with electricity as well as heat to make process steam in a heat

recovery boiler.

The turbine rotates at 6.912 rpm. Exhausting gases are piped through a boiler and produce 35,000 pounds of steam per hour at 250 psig. and 600° F. for Gates Rubber's processing applications. The exhaust gases are still rich in oxygen, and by burning additional fuel in the boiler, 120,000 pounds of steam per hour can be supplied for factory use.

Rubber Symposia

(Continued from page 86)

Baker. American Viscose Corp.; "Utilization of Cotton." H. R. Schwarz. Wellington Sears Co.; and "Adhesion of Textiles," L. W. Reeves, The General Tire & Rubber Co.

Abstracts of these papers, when available, will be published in Rubber World. John Bolt, Naugatuck Chemical Division of United States Rubber Co., has been elected chairman of the Southern Rubber Group to fill the unexpired term of the late Harmon Connell. William Gerrow. Goodyear Chemical Division, succeeds Mr. Bolt as a director of the organization. H. R. Grove, International Shoe Corp., the Group's chaplain, led a moment of prayer for Mr. Connell.

Gordon Research Meeting Slates II Elastomer Talks

An elastomer conference will be held at Colby Junior College, New London, N. H.. July 29-August 2, during the Gordon Research Conferences for 1957, which will take place from June 10 to August 30. Eleven technical papers have been scheduled for presentation.

Consisting of scheduled lectures and free discussions, the Conferences were established to stimulate research in universities, research foundations, and industrial laboratories. Programs stress the latest scientific developments and attempt to point out approaches for further progress.

The following papers have been scheduled for the elastomers conference: "A Study of the Reaction of Ozone with SBR Rubbers," E. R. Erickson, R. A. Berntsen, and E. L. Hill. Augustana College; "Effect of Gamma Radiation on Elastomers." John Born. Goodrich Research Center; "Properties of Carbon Black Recovered from Cured Rubber Stocks," Merton Studebaker, Phillips Chemical Co.; "Carbon Black Surface Functional Groups—Their Identification and Effects," J. W. Hallum, K. A. Burgess, F. Lyon, Columbian Carbon Co.

Also, "Thermodynamics of Rubber during Reversible Extension," P. Thirion, Institut Français du Caoutchouc; "Mechanism Studies of Isoprene Polymerization with Ziegler-Type Catalysts," W. M. Saltman, W. E. Gibbs, Jogiuder Lal, and Bernard Wargotz. The Goodyear Tire & Rubber Co.; "Effect of Cis-Trans Ratio on the Physical Properties of 1.4-Polybutadiene," J. N. Short, Gerard Kraus, and Vernon Thornton. Phillips Petroleum Co.

Also. "The Dependence of Tack Strength on Molecular Properties." L. A. McLeod and W. G. Forbes, Polymer Corp., Ltd.; "Freeze Agglomeration of Latex." Leon Talalay and Howard S. Smith. Sponge Rubber Products, and Ralph N. Kingsbury and Donald G. Dobay. The B. F. Goodrich Co.; "Kinetics of Cross-Linking of Tread Stocks." John O. Cole and G. R. Parks. Goodyear; and "Cross-Linking of Polyurethane Elastomers." O. C. Keplinger and E. E. Gruber, General Tire & Rubber Co.

Requests for attendance should be addressed to W. George Parks. Director. Department of Chemistry. University of Rhode Island. Kingston. R. I. Attendance is limited to 100.

Akron U Short Course

The second annual short course on "The Chemistry and Physics of Elastomers" will be given by the Institute of Rubber Research of The University of Akron, Akron, O., June 10-15. The course will be limited to the first 25 registrants.

Lecturers and the subjects of their talks will be the following: G. Stafford Whitby. Akron U, "Recent Developments in Hevea Latex": Maurice Morton, director, Institute of Rubber Research, "Chemistry of Synthetic Rubbers"; Kenneth W. Scott, The Goodyear Tire & Rubber Co., "Physical Behavior of Elastomers: Elasticity Theory; Dynamic Properties."

Also James P. Berry, Akron U. "Physical Behavior of Elastomers: Relaxation; Tear: Abrasion"; Fred J. Bueche. University of Wyoming, "Physical Behavior of Elastomers: Tensile Strength: Reinforcement"; and Dr. Morton, "Chemistry of Vulcanization."

Direct inquiries to Dr. Morton.

News About People

Harry L. Fisher who recently retired as director of the Tlargi Rubber Technology Foundation and the University of Southern California, has been elected as the "first honorary member" of the Washington Rubber Group and also as an honorary Fellow of the Institution of the Rubber Industry, London. England. Dr. Fisher is a past president of the American Chemical Society and is a fellow and member of many other scientific and technical societies. In addition, Dr. Fisher was elected an honorary member of Committee D-11 on Rubber of the American Society for Testing Materials at its February meeting.

H. J. Deery, Jr., Dean E. Humphrey, Edward P. McLaughlin, Adam Orzechowski, Manuel Perdigao, and Robert E. Ross have joined the staff of the Cambridge, Mass., research and development laboratories of Godfrey L. Cabot. Inc., Boston, Mass.

E. T. Towe has been given a special assignment with the sales manager's office of The Seiberling Rubber Co.. Akron, O., and has been succeeded as Akron sales district manager by Frank Hager, formerly assistant manager there.

John M. Miller, since 1950 assistant general manager of the tire division of United States Rubber Co., New York, N. Y., has retired after 17 years of service with the company.

Newton H. Tuthill, general manager of the Hard Rubber Division of American Hard Rubber Co., has been elected vice president of the parent company. He has served the company since 1937.

William J. Hogg has been appointed sales manager in charge of rubber chemicals and plastics of Naugatuck Chemicals, division of Dominion Rubber Co., Ltd., Elmira, Ont., Canada.

David A. Edwards has become plastics technical sales representative in the Akron, O., area for Naugatuck Chemical Division, United States Rubber Co., New York, N. Y.

Olin Smith has been named Philadelphia branch sales office manager for Diamond Alkali Co., Cleveland, O., succeeding C. F. Wolters, Jr., who has retired after 37 years of service with the company. Robert R. Wood replaces Mr. Smith as assistant Chicago branch sales office manager.



John Yacos, Jr.

John Yacos, Jr., has joined the technical staff of The Wilson Rubber Co., Canton, O. As research chemist, he will supervise the company's research and development program, including the testing of industrial, surgical, and household rubber gloves and related products.

T. F. Hart, M. H. Jellinek, and R. S. Wishart, Jr., have been named product managers of silicone resins and sizings, silicone specialties, and silicone fluids, respectively, for the silicones division of Union Carbide & Carbon Corp., New York, N. Y.

Joseph L. Pert has been appointed Naugahyde vinyl coated fabrics sales manager at the Mishawaka, Ind., plant of United States Rubber Co., New York, N. Y.

Bernard B. Bowling has been added to the sales staff of the plastics division of The Seiberling Rubber Co., Newcomerstown, O.

Edward M. Bader has been named manager of quality control and inspection at B. F. Goodrich Aviation Products, Akron, O.

Walter D. Baldwin has been appointed assistant general manager of the tire division of United States Rubber Co.. New York. N. Y., succeeding John M. Miller, who has retired. Mr. Baldwin joined the company in 1935 as a tire salesman.

Gerald L. Dennis has been appointed manager of field sales for Naugatuck Chemical Division. United States Rubber Co.. Naugatuck. Conn. He was formerly Los Angeles district manager for the company.

Miller W. Swaney, director of the products research division of Esso Research & Engineering Co., New York, N. Y., has been named coordinator of chemicals and lube oil processes. He succeeds Harold J. Rose. Named director of the products research division of Esso Research was Neil V. Hakala, Leonard E. Moody has been advanced to associate director of the division; while Ben W. Geddes has been promoted to assistant director.

Charles S. Mohaupt has been named technical sales service manager for Goodrich-Gulf Chemicals, Inc., Cleveland, O. Before joining the company in 1955, he had been associated with The B. F. Goodrich Co. for 21 years.

Charles E. Richey has been made staff assistant to the vice president of The Electric Auto-Lite Co., Toledo, O.

Wayne E. Burger, treasurer of Goshen Rubber Co., Inc., Goshen, Ind., has been elected to membership in the Controllers Institute of America. New York, N. Y.

John T. Pope has been promoted to chief staff engineer of The Seiberling Rubber Co., Akron. O., succeeding I. R. Heller, who has resigned.

John F. Neuman and Milo Dellmann have been named Midwest and West Coast sales representatives, respectively, for Standard Tool Co., Leominster, Mass.

Philip P. Percich has been named assistant manager of the hose sales department of The Goodyear Tire & Rubber Co., Akron, O.

William B. Richardson, manager of the New England division of American Mineral Spirits Co., Chicago, Ill., was recently honored at a banquet commemorating his twenty-fifth anniversary with the company.

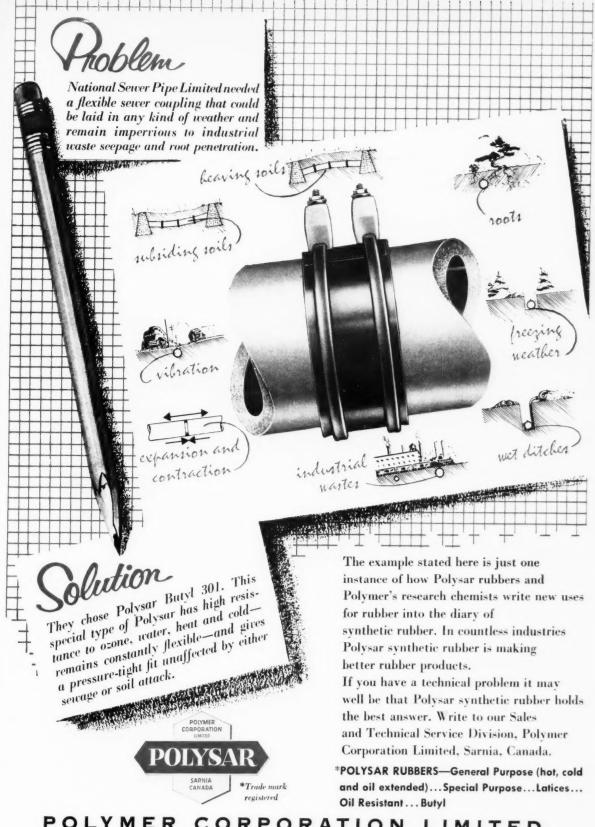
Vincent D. Nutile and Joseph H. Koslowski have joined the technical sales staff of the coatings and adhesives department of Borden Co.'s chemical division, New York, N. Y. They will cover the New England area.

J. R. Jones has been reassigned to the auto tire sales department of The Goodyear Tire & Rubber Co., Akron, O.

J. T. Dunn, since 1954 a group leader in the research department of Carbide & Carbon Chemicals Co., New York, N. Y. has been named assistant to the company's director of research, **Franklin Johnston**.

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Leroy J. Davis, Jr.

Robert A. Martin and Daniel L. Worth have joined the research staff of Alco Oil & Chemical Corp., Philadelphia, Pa.



Robert A. Martin

Thomas F. Cockrem has been named manager of highway transportation at The Goodyear Tire & Rubber Co., Akron, O., succeeding George M. Sprowls, who has retired after 44 years of service with the

J. Nelson Manning, Jr., has been named general production manager of the clothing division of Sawyer-Tower, Inc., Boston,

Jack E. Davis has been promoted to special staff assistant in the sales department of Diamond Alkali Co., Cleveland, O.

Felix P. Juraska has joined American Hard Rubber, New York. N. Y., as controller. He was formerly assistant controller for Montgomery Ward & Co.



Robert P. Restrepo

Robert P. Restrepo, John M. Allan, and Leroy J. Davis, Jr., have been named technical sales representatives to the midwestern, mideastern, and Philadelphia areas, respectively, for Alco Oil & Chemical Corp., Philadelphia, Pa.

Robert McIlvane has been named assistant manager in charge of telephone cable sales for Anaconda Wire & Cable Co., New York, N. Y. Ary Mossiman has been appointed manager of market research.

N. E. Bolton, R. B. Gosnell, R. J. Hanna, M. A. Stephens, and G. W. Warren have joined the development department at the South Charleston, W. Va., plant of Carbide & Carbon Chemicals Co., New York, N. Y.

Henry F. Smith has been appointed a technical sales representative to the Central Atlantic area for Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn.



Pach Bros.

Harold M. Parsekian



John M. Allan

W. D. Lahey has been appointed sales manager of adhesives for B. F. Goodrich Industrial Products Co., Akron, O.



Pach Bros.

Earle S. Ebers

Earle S. Ebers has been advanced to assistant general manager of Naugatuck Chemical Division of United States Rubber Co., Naugatuck, Conn., and has been succeeded as general sales manager by Harold M. Parsekian, formerly assistant general sales manager.

L. M. Thul has been advanced to automotive manufacturing trades sales manager, coated abrasives division, Minnesota Mining & Mfg. Co., St. Paul, Minn. Also promoted were Donald J. Scholten, to central region sales supervisor for the division, and Ellsworth W. Erickson, to assistant superintendent of factory quality control.

John G. McNab has been appointed coordinator of petroleum products and medical research at Esso Research & Enginering Co., New York, N. Y.



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PRODUCT	APPLICATION
CIRCOSOL 2XH. An elasticator of special hydrocarbon structures derived from petroleum.	Manufacture of oil-extended polymers. Plasticizer and softener for butadiene-styrene polymers, natural rubber, and combinations of both.
CIRCO LIGHT. A general-purpose, naphthenic type softener.	Manufacture of nonstaining reclaims and butyl inner tubes. Processing regular neoprene and natural rubber.
SUNDEX 53. A moderately aromatic product compatible with natural rubber, regular neoprene, and butadiene-styrene polymers.	Manufacture of oil-extended polymers. Processing tire tread stocks, rubber footwear, matting, toys, semihard rubbers, etc. Extending high Mooney Neoprene type WHV with a maximum loading of 50 parts per 100 parts neoprene.
SUNDEX 1585. A predominantly aromatic product compatible with natural rubber and butadiene-styrene polymers.	Particularly useful in the manufacture of oil-extended polymers where easy processing and optimum aromaticity are required.
SUNDEX 85. Highly aromatic product compatible with natural rubber, but adienestyrene polymers, neoprene (regular and WHV), and acrylonitrile polymers.	Manufacture of low cost neoprene articles. Particularly useful for extending neoprene with exceptionally high loadings-75 to 100 parts Sundex-85 to 100 parts neoprene type WHV.
SUNDEX 170. A relatively aromatic product with a high molecular weight.	Manufacture of mastic floor tile, battery cases, and resinous binders.
SUNDEX 41. A complex, dark colored blend of high molecular weight petroleum fractions and a specially prepared asphaltum.	Processing natural rubber and butadiene-styrene poly- mers.
SUN PROCESS AID 515. A non-staining, highly paraffinic type petroleum derivative with a low viscosity and fair processing ability.	Manufacture of butyl inner tubes. Processing natural rubber and butadiene-styrene polymers where color stability in the finished vulcanizate is important.
SUN PROCESS AID 551. A non-staining, highly paraffinic type product with a low volatility, medium viscosity, and fair processing ability.	Manufacture of oil-extended polymers where non- staining of the finished commercial article is important.
SUN PROCESS AID 594. A medium viscosity, naphthenic type petroleum derivative with a low volatility and good processing ability.	Manufacture of oil-extended polymers. Dry mixing process for natural rubber and butadiene-styrene polymers. Economical where some discoloration in the finished rubber can be tolerated.
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Charles F. Radley, director of publicity and member of the board of directors of Oakite Products, Inc., New York, N. Y., has retired after 40 years of service with the company.

Dale A. Dougherty has joined Tyer Rubber Co., Andover, Mass., as manager of industrial relations and industrial engineering.

Frank B. Norton has been appointed sales manager of Firestone International Co., Akron, O. He was previously sales director of Firestone Tire & Rubber Co. of India, Ltd.

Robert M. Hill has joined Mohawk Rubber Co., Akron, O., as manager of tire compounding.



Robert M. Hill

Albert A. Garthwaite, Jr., has been elected president of Lee Rubber & Tire Corp.. Conshohocken. Pa.. succeeding his father, A. A. Garthwaite, who was named chairman of the board.



Albert A. Garthwaite, Jr.



Harold J. Rose

Harold J. Rose has been appointed assistant general manager of the chemical products department of Esso Standard Oil Co., New York, N. Y. He was previously coordinator of chemicals research for Esso Research & Engineering Co.

F. J. Reighley has been advanced to manager of the interplant department of The Firestone Tire & Rubber Co., Akron, O., succeeding M. E. Ake, who retired in January after 45 years with Firestone.

Edward G. Van Buskirk has been named development manager of the footwear and general products division of United States Rubber Co., New York, N. Y. David D. M. Streed succeeds him as assistant development manager of the division.

Harry S. Mooradian has been advanced to vice president in charge of manufacturing for The Dayton Rubber Co., Dayton, O. The company's longest service employe, he joined the firm 44 years ago as a tire builder.



Harry S. Mooradian

James L. Vaughan has joined the Dewey & Almy Chemical Co. Division of W. R. Grace & Co., Cambridge, Mass., as assistant research director in charge of process design and development. He was formerly associated with National Research Corp.

Edward Wray has joined Sequoia Processing Co., Redwood City, Calif. He was formerly with Anaconda Wire & Cable Co.

Philip Bergh has been advanced to advertising and sales promotion manager of the textile division of United States Rubber Co., New York, N. Y.

Leverette A. Anderson has been appointed sales representative to the Ohio territory for Whittaker, Clark & Daniels, Inc., New York, N. Y.



Leverette A. Anderson

James P. Okie has joined Diamond Alkali Co., Cleveland, O., as assistant general manager of its plastics division. He was formerly with Olin Mathieson Chemical Corp.

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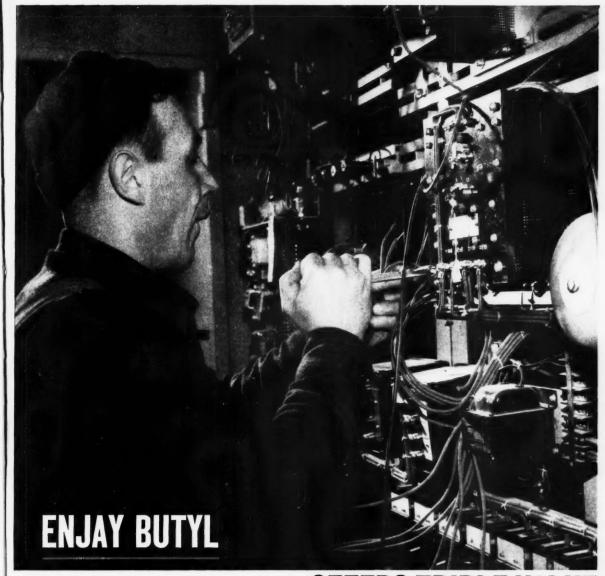
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April, 1



James P. Okie

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News Briefs

The Goodyear Tire & Rubber Co., Akron, O., reports that certain taxi fleets perating on its Captive-Air dual-compartment safety tire have had an average coadside tire delay incidence of less than one per million tire miles compared with the 190 delays per million tire miles for tubed tires and the 55 delays per million tire miles for cabs mounted on tubeless tires.

H. O. Canfield Co., Bridgeport. Conn., has added new facilities for the bonding of rubber to metals.

B. F. Goodrich Industrial Products Co., Akron, O., working with Bell Helicopter Corp., has developed a new cement for use in the construction of all-metal rotor blades for military and commercial helicopters.

Case Institute of Technology, Cleveland, O., has contracted for the building of a \$7,000,000 Case Industrial Nuclear Center, which is being planned under the joint sponsorship of the Institute and some industrial firms interested in research requiring a high flux engineering test reactor.

American Enka Corp. has moved into new, larger offices at 530 Fifth Ave., New York, N. Y.

Hercules Powder Co., Wilmington, Del., has begun capacity production at its tall oil fractionation plant in Savannah, Ga., which manufactures resins, purified fatty acids, and related products from crude tall oil.

Vickers Petroleum Co., Inc., Potwin, Kan.. will build a \$2,000,000 petrochemical plant on the site of its Potwin refinery for the production of such aromatics as benzene, toluene, xylene, and other hydrocarbons used in the synthetic rubber, plastics, resin, and paint industries, among others.

LaCrosse Rubber Mills Co., LaCrosse, Wis., and Rubber Corp. of California, Garden Grove, Calif., have been contracted by the U. S. Army Philadelphia Quartermaster Depot for \$52,122 and \$33.087 worth of men's rubber overshoes, respectively, for the U. S. Air Force.

The Timken Roller Bearing Co., Canton, O., reveals that 53% of its 15,000 employes have been with the firm for 10 years or more, of whom 8% have had a 25- to 49-year tenure, 11%, 20-40 years, 11%, 5-19 years, and 23%, 10-14 years.

Columbian Carbon International, Inc., New York, N. Y., is the new name of Binney & Smith International, Inc.

Southern Research Institute, Birmingham, Ala., will sponsor a non-technical conference on missiles, rockets, and space travel, May 16 and 17. Dan A. Kimball, president, Aerojet-General Corp., and vice president and a director of the General Tire & Rubber Co., will be among the six scheduled speakers.

Mobay Chemical Co., St. Louis, Mo., has opened a new district sales office at 405 Lexington Ave., New York, N. Y., under the direction of L. Dean Tyler, manager of the company's eastern sales district.

Westman Rubber Works, Compton, Calif., has been formed to produce molded specialties for the oilfield and aircraft industries.

B. F. Goodrich Co.'s Lima, Peru, associate manufacturing company, Lima Rubber Co., has begun operations of its tire manufacturing plant. Rubber from eastern Peru will be used in the company's products.

Petroleum Chemicals, Inc., New Orleans, La., will build a \$500,000 regional office building at its Lake Charles, La., plant to house operating and engineering department personnel.

The Wooster Rubber Co., Wooster, O., reveals that new production techniques for producing its Rubbermaid Shelf-Kushions in continuous rolls will result in the largest sales promotion effort for any new product in the firm's history.

Parker Appliance Co., Cleveland, O., has developed a rubber O-ring compound, No. 37-541, which is resistant to perchloroethylene dry cleaning fluid, making it suitable for use in dry cleaning equipment.

The Goodyear Tire & Rubber Co.'s tubeless tires, wheels, and brakes are being used to equip a new Swedish delta-type supersonic jet airplane, the Saab J35 Dragon.

Goodrich-Gulf Chemicals, Inc., Cleveland, O., is converting a production line at its Institute, W. Va., plant for the manufacture of 50,000 tons annually of Ameripol cold (SBR) rubber. The \$2-million project will be completed early next year.

Phillips Petroleum Co., Bartlesville, Okla., has licensed Showa Denko K. K., of Japan, to use the Phillips-developed catalytic process for making rigid polyethylenes.

The Dayton Rubber Co., Dayton, O., has appointed Vonn-Young Co., Honolulu, warehouse distributor of its automotive and industrial products to the Territory of Hawaii markets.

Clevite Corp., Cleveland, O., has opened a new sales office at 4629 Harper Bldg., Van Nuys Blvd., Van Nuys, Calif. Two of its manufacturing units, Cleveland Graphite Bronze Co. and Clevite Harris Products, Inc., will be represented initially under the direction of Joseph Palsulich and Henry M. McCarthy, respectively.

Parker Appliance Co., Cleveland, O., has appointed Robert B. Porter Co., Glendale, Calif., distributor of its synthetic rubber O-rings for sealing applications and related molded parts.

Wyandotte Chemicals Corp., Michigan Alkali Division, Wyandotte, Mich., has reduced the price of its Pluronic and Tetronic series of block-polymers by 1½-7¢ a pound.

Union Carbide & Carbon Corp.'s LE-46 Silicone Oil Emulsion is being used very successfully as a release agent in the post-calendering and pattern-embossing operations of automotive rubber floor mat production, the company reports.

Packard Electric Division, General Motors Corp., Warren, O., recently completed an order for 350 grooved-rubber pads for the filtering units of Skeggs-Leonards artificial kidneys.

Kelco Co., San Diego, Calif., is building a new \$250,000 research laboratory to continue its research into algin and its derivatives, used as thickening, suspending, stabilizing, emulsifying, and gel-producing agents.

Arizona Chemical Co., New York, N. Y., jointly owned by International Paper Co. and American Cyanamid Co., has named N. S. Wilson & Sons, Boston, Mass., distributor of its Acintol tall oil fractions, in Maine, New Hampshire, Massachusetts, Vermont, and Rhode Island,

Witco Chemical Co., New York, N. Y., has organized an International Division under the direction of Board Chairman Robert I. Wishnick. L. D. Carver has been appointed manager of technical sales for the new division.

Art Sawyer & Associates, Detroit, Mich., has been organized as sales agents of materials to the automotive industry. Companies whose products will be handled by the new firm include United States Rubber Co., Jason Corp., and E. L. Mansure Co.

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OBITUARY

Charles S. Grainger

Charles S. Grainger, a director of The Olympic Tyre & Rubber Co., Melbourne, Victoria, Australia, and of its parent company, Olympic Consolidated Industries. Ltd., died March 3 in a Melbourne Hospital, during a convalescence following two major operations. He was 64.

Mr. Grainger was also a director of Olympic Cables, Pty. Ltd., and of Olympic General Products, Pty. Ltd., at the time of his death. He had retired from active participation in the affairs of the four companies in 1955.

One of Australia's foremost experts on the design and manufacture of tires and electric cables, Mr. Grainger was appointed chief technical executive of Olympic Tyre & Rubber when it was founded in 1933.

He made many trips abroad to study tire and cable manufacturing techniques for adaptation to Australian conditions. Nine such visits were made to the United States.



Charles S. Grainger

Financial

Allied Chemical & Dye Corp., New York, N. Y., and subsidiaries. For 1956: net earnings, \$47,004,945, equal to \$4.88 a share, compared with \$52,127,975, or \$5.44 a share, in 1955; sales, \$668,937,533, against \$628,514,087; federal income taxes. \$32.717.637, against \$41,059.735.

Allis-Chalmers Mfg. Co., Milwaukee, Wis. For 1956: net income, \$19,719,188, equal to \$2.42 a common share, compared with \$23,864,048, or \$3.03 a share, in 1955; net sales, \$547,439,265, against \$535,069,085.

American Cyanamid Co., New York, N. Y., and wholly owned subsidiaries. Year ended December 31, 1956: net earnings. \$44,247,158, equal to \$4.21 a common share, compared with \$38,713,666, or \$4.07 a share, in the previous year; sales \$500,651,279, against \$451,088,434; income taxes, \$41,000.000, against \$36,000, 000

American Hard Rubber Co., New York, N. Y. For 1956: net income, \$959,628, equal to \$2.62 a common share, against \$952,560, or \$2.59 a share, in 1955; sales \$26,554,872, against \$22,413,859.

Brunswick-Balke-Collender Co., Chicago, III. For 1956: net income, \$3,364,-390, equal to \$6.15 a share, contrasted with \$1,371,771, or \$2.40 a share, in the preceding year.

Armstrong Cork Co., Lancaster, Pa., and domestic subsidiaries. For 1956: net profit, \$13,320,380, equal to \$2.56 a share, against \$14,542,289, or \$2.83 a share, in 1955; net sales. \$247,401,423, against \$249,385,639; federal income \$13,700,000, against \$15.950,000.

Belden Mfg. Co., Chicago, Ill. For 1956: net earnings, \$1,802,321, equal to \$4.63 a share, against \$1,582,203, or \$4.09 a share, in 1955.

Sidney Blumenthal & Co., Inc., New York, N. Y. For 1956: net loss, \$378,349, compared with net loss of \$1,998,375 the vear before.

Borden Co., New York, N. Y. For 1956: net income, \$23,602,746, equal to \$5.01 a \$4.61 a share, in 1955; sale, \$876,987,184 (a new high), against \$810,126,624.

Borg-Warner Corp., Chicago. Ill. For 1956: net profit, \$35.841.952. equal to \$4.01 a share, contrasted with \$41,075,084. or \$5.17 a share, the year before.

Brown Rubber Co., Inc., Lafayette, Ind. Twelve months to December 31, 1956: net earnings, \$26,425, equal to 7¢ each on 378,148 capital shares, contrasted with \$733,628, or \$1.94 each on 377,818 shares, in the preceding 12 months; federal income taxes, \$12,000, against \$757,500.

Philip Carey Mfg. Co., Plymouth Meeting, Pa. For 1956: net profit, \$2,560,413, equal to \$3.01 a share, against \$2,637,239, or \$3.04 a share, the year before.

Celanese Corp. of America, Charlotte, N. C., and domestic subsidiaries. Year ended December 31, 1956: net profit, \$16,863,224, equal to \$2.08 each on 5,844,954 common shares, compared with \$11,220,830, or \$1.81 a share, in the preceding year; net sales, \$188,307,250, against \$177,502,026; federal income taxes, \$6,200,000, against \$8,500,000.

Cooper Tire & Rubber Co., Findlay. O. For 1956: net income, \$410,389, equal to \$1.60 a share, against \$400,011, or \$1.56 a share, in 1955.

Dayton Rubber Co., Dayton. O. Three months ended January 31, 1957: net profit, \$441,412, equal to 46¢ a share, against \$435.833, or 52¢ a share, a year earlier: net sales, \$16,353,349, against \$14,740,680.

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., and consolidated subsidiaries. Twelve months to December 31, 1956: net profit, \$383,401,308, equal to \$8.20 a common share, compared with \$431,555,884, or \$9.26 a share, the year before: sales, \$1,917,353,387, against \$1,941,384,933.

Diamond Alkali Co., Cleveland, O. For 1956: consolidated net earnings, \$10,380.-141 (a new high), equal to \$3.83 a common share, compared with \$8,442,908, or \$3.11 a share, in 1955; sales, \$121,261,571 (another record), against \$110,292,280; federal income taxes, \$11,607,400, against \$9,-675.435.

The Eagle-Picher Co., Cincinnati. O. Quarter ended February 28, 1957: net profit, \$1,364,318, equal to \$1.36 a share. compared with \$1,028.567, or \$1.04 a share, a year ago: net sales, \$31,862,756. against \$29,829,500.

Farrel-Birmingham Co., Inc., Ansonia, Conn. Year ended December 31, 1956: net earnings, \$985,481, equal to \$3.08 a share, compared with \$1,320,386, or \$4.13 a share, in the preceding year; net sales. \$50,238,519 (a new high), against \$37, 852,235; federal income taxes, \$1,007,000. against \$1,331,000.

Flintkote Co., New York, N. Y., and subsidiaries. For 1956: net earnings, \$5.-801,973, equal to \$3.97 a share common. compared with \$4,945,693, or \$3.57 a share, the year before; net sales, \$107,-085,509, against \$100,995,922; income taxes, \$4.615,580, against \$4.697.688.

Goodvear Tire & Rubber Co. of Canada. Ltd., New Toronto, Ont., Canada. For 1956: net profit, \$6,222,804, equal to \$23.06 a share, against \$4,397,946, or \$15.96 a share, in the preceding year.

(Continued on page 134)



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News from Abroad

Malaya

Blackman Report Stresses New Methods, Lower Costs

The committee of British experts which, under the chairmanship of Prof. G. E. Blackman, of Oxford University, was appointed by the Rubber Producers' Council last year to report on the Malayan rubber industry, has now submitted its recommendations. While the full report had, at the time of this writing, not yet been published, details have become known. From these it appears that the main point made was that the cost of producing natural rubber must be kept low enough so that it can be sold between 75-70 Straits cents a pound. and that 60 cents would be even better. It was stressed that not only should output be increased and production costs reduced, but quality must be improved; the Rubber Export Registration Committee should be given more power, to enable it to guarantee the export standards expected by buyers.

Other recommendations were: an increase in the rubber research cess from the present half cent to 3/4 cent per pound, for the next 10 years; government legislation forbidding "paper rubber speculation" in which there is no actual movement of rubber; higher pay for the staff of the Rubber Research Institute and for officers of the British Rubber Producers' Research Association staff: the extension of Malayan research advisory services and the launching of technical and advisory services in North America and Britain. It was noted that if the Natural Rubber Development Board's publicity work could be cut, the industry could save £50,000-60,000 annually; attention was drawn to the fact that though the value of rubber exported from Malava between 1954 and 1956 came to £437,500,000, only £2,380,000 were spent on research.

New Methods

What has so far been published in the local press of the Blackman committee's recommendations suggests that the most important contribution of the report may well be that it will bring home forcibly to the Malayan rubber industry in general the need—recognized for some time by leading companies and acted on by individual concerns—of striking out along new paths to meet and to live with synthetic rubber competition.

A recent interview in Straits Times with D. H. Frean and O. B. Wolsteholme, engineers of General Electric Co. (Malaya), Ltd., reveals new methods that some companies already are testing to achieve the very ends of which the Blackman report aims. These engineers, we understand, have

developed (1) a multi-purpose drying tunnel for rubber by which drying costs can be cut in half and capital expenditure reduced by one-third; (2) aero-foil fans to convert waste products like skimmed latex into salable products; and (3) streamlined processing for a steady production flow. The Ulu Tiram (Johore) Rubber Co., which installed a unit for the new method under the direction of technologists, is said to have achieved such satisfactory results that it has added three more units.

Rubber Export Registration Board

Those sections of the Singapore rubber trade which have recently been agitating for the abolition of the Rubber Export Registration Board, will find little comfort in the Blackman recommendation to increase the powers of that Board. At the same time, the fact that larger powers for the Board were considered necessary and important serves to prove how unfounded are the accusations by critics that Singapore rubber traders are being exploited by American and British buyers who under cover of the shipping and packing ordinance make "unnecessary" or "frivolous" quality claims; and it also serves to underline the accuracy of the conclusions of the Rubber Manufacturers Association of New York, as to the causes of the difficulties connected with the maintenance of proper shipping and packing standards. In a letter to the Board, on the subject of its future status (copies of which were sent to leading rubber trade organizations in Malaya and several Malayan papers), the position of the American rubber consumer was explained, as RMA, stated:

"The reason for all this trouble and the cause of our constant complaint is not due to claims and arbitration procedures in terminal markets, but is entirely due to the fact that the rubber received does not conform to the standard for the grade purchased.

"This is undeniable fact, and if there is to be an improvement, the corrective measures must be taken by the business communities and governments of rubber producing countries."

"Excessive Export Duty"

"The greatest single factor hampering the industry in its struggle to become competitive with synthetic rubber," is how the Rubber Producers' Council, in its 1956 report, describes the government's export duty. Through this "excessive duty," introduced when the government started its \$280,000,000 replanting scheme in 1955, the natural rubber industry has more than paid for the 1956 share of the cost of the scheme, and government is making a profit on the transaction, it is claimed.

Aided Replanting

While criticizing the duty, the Council nevertheless stated its belief that the replanting scheme would probably be a success; it gave aid to estates without sufficient resources, permitting them to carry on during the unproductive period of replanting and enabled other estates to expand their high-yielding areas.

In regard to smallholders, the report went on, the improved price level last year posed the problem of convincing many of them to cut down trees which still yielded a living and to forego a brief present advantage in order to benefit from future high outputs obtainable from high-yielding material planted now. Various measures were carried out to encourage replanting by smallholders, and at present a scheme for block, new planting is under consideration.

Replanting Progress

From other sources it is clear that small-holder replanting is more popular in some districts than in others. Good progress is reported from Malacca, where 9,000 acres were replanted in 1956, almost 300% over the year's quota for the area. Judging by the large number of applications that continue to be received by the local replanting office. 1957 should be a good replanting year for Malacca. The Replanting Board here and also in Negri Sembilan seems to be doing good work.

One of its main difficulties seems to be the eradication of lallang, a hardy weed, which interferes with the development of young rubber and which is not easily got rid of; in many cases, smallholders are required to clear their land of lallang before receiving the replanting grant.

Incidentally, what must be an innovation has been noted on smallholdings, renting tractors for cultivation.

New planting is going ahead in Johore, but the amount will be limited to about 6,000 acres in 1957; in 1958, when new rubber budwood becomes available, the area of new planting may be increased to 12,000 acres.

New Wage Plan Proposed

The National Union of Plantation Workers has for some time expressed dissatisfaction with the present wage system which is linked to the price of rubber. Recently a new three-year plan was drawn up which is to be discussed at a meeting of delegates from Union branches in all parts of the Federation. This plan calls for various new benefits including: minimum wage plus cost of living allowance and a prosperity bonus; a closed shop policy (this, it is held, would indirectly guarantee that undesirable elements or their agents would be kept off estates); the creation of a joint industrial council to effect rapid settlement of disputes; a clubhouse for meetings and social gatherings for workers; an orphanage for workers' children, and also scholarships and hostels for workers' children to enable them to get more education and better themselves; homes for aged workers; better medical care.

It is understood that the Union intends



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WING-STAY S won its fame in foam for these good reasons: 1. It is easily emulsified and incorporated in latex 2. It is not extracted by water 3. It is nonvolatile, even when large surface areas are involved 4. It is non-discoloring 5. It provides good all-round protection 6. It is low in cost.

If you want protection from heat, sunlight or age that will bring fame to your products—foamed or solid—get the full story on Wing-Stay S. Samples plus the latest *Tech Book Bulletins* are yours by writing to: Goodyear, Chemical Division, Akron 16, Ohio.

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ind it's the lead-scoloring, non-scoloring, non-scoloring by water 3. It is easily by water 3. It is non-scow in cost.

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High Polymer Resins, Rubbers, Latices and Related Chemicals for the Process Industries

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to make clear to plantation workers the threat of synthetic rubber and to emphasize the need of producing rubber at competitive prices. At the same time, however, the Union will insist on the recognition of workers' interests, especially if they are to work hard to meet this need.

Meanwhile, estate managers have had to warn plantation workers that because of the fall in the price of rubber, their pay may be cut during the second quarter of 1957. During the first quarter, tappers were getting \$3.65 (Straits) daily, and field workers \$3.25; these amounts may have to be reduced by 35 cents a day.

Rubber Trade Notes

The government ban on the export of Tj.1 selfed rubber seed, scheduled to expire March 31, 1957, has been extended to the end of this year. In announcing the decision, made after consultation with the Rubber Producers' Council and in full agreement with this body, the government explained that it had no desire to interfere with the legitimate export of rubber planting material, but that greatly increased exports in the last two years necessitated the extension of the ban to insure an adequate supply of seed to Federation producers. During 1956, exports of Ti.I seed, largely used for smallholdings in Malaya, came to 12,000,000 and went mainly to Thailand. North Borneo, Sarawak, and Nigeria; small quantities were also sent to India, Burma, New Guinea, and Ceylon.

The Singapore Rubber Goods Manufacturers' & Traders' Association was recently formed by 11 rubber factories in Singapore and Johore. The companies together employ 3.000 to 4.000 people and produce all kinds of rubber goods for local consumption as well as for export. It is understood that additional rubber factories will join the new organization shortly.

Germany

DKG Meeting Subjects— Cure, Stress Relaxation

A feature of the meeting of the Hamburg District Section of the Deutsche Kautschuk Gesellschaft, on October 9, 1956, was a review by W. Steele on the progress in research on stress relaxation and on vulcanization carried out at the Rubber Department of the Hannover Institute of Technology.

The highly sensitive stress-relaxation reaction was thoroughly studied, on rubber thread, with a view to developing exact methods of measuring the oxidation degradation of natural rubber vulcanizates. It could be shown that under special conditions the rate of relaxation is constant, whereby evaluation of test results is greatly facilitated. The rate of relaxation is practically independent of the strain as well as of pretreatment temperature in the presence of technically pure nitrogen.

Research on the kinetics of thiuram

vulcanization in the presence of ZnO was extended to the nitrile rubber, Perbunan 2818. Both the decrease in the concentration of thiuram disulfide and the increase in the Zn-dithiocarbaminate content of the vulcanizates are first-order reactions, and two-thirds of the thiuram disulfide is converted to Zn-dithiocarbaminate, independently of temperature, as in the case of natural rubber and the styrenebutadiene rubber Buna S3. It was emphasized, however, that the difference between the rate constants for thiuram decrease and dithiocarbaminate increase is considerably greater in the case of Perbunan than in that of either natural rubber or Buna S3.

Numerous measurements of maximal swelling of natural rubber vulcanized with thiuram indicated that the change in the reciprocal swelling maxima (cross-linking) with curing time is a reaction of the first order, and that the formation of dithiocarbaminate and cross-linking are equivalent processes. Hence it was concluded that cross-linking results in the formation of dithiocarbaminate.

Further experiments suggest that in the case of thiuram vulcanization in the presence of ZnO, we are dealing with heterogeneous catalysis. The relation of rate constants for thiuram decrease and dithiocarbaminate increase, with varying ZnO and constant thiuram, as well as with simultaneous variation of thiuram and ZnO (but with the same excess ZnO) was also studied.

Preliminary results indicated that when natural rubber was vulcanized with thiuram disulfide in the presence of tellurium dioxide, 66 mol % of Tell-dithiocarbaminate is formed after a zero order reaction with a pronounced induction period. At 120° C. and over, the dithiocarbaminate immediately undergoes reduction to elementary tellurium; the vulcanizates darken, and the yield in dithiocarbaminate passes through a maximum with curing time.

Recent work on the kinetics of accelerated cure of natural rubber with mercaptobenzothiazole (MBT) and sulfur or zinc mercaptide and sulfur (1 mol MBT or ZnMBT per S₈) in the presence of ZnO showed that sulfur decreased at all temperatures used, after a first-order reaction, and there was no difference between the rate-constants. A minimum amount of accelerator must be available, but otherwise the concentration of the accelerator is without effect on the rate at which sulfur decreases. The amount of MRT or ZnRMT used up during cure increases with curing temperature. On the basis of acceleration with ZnMBT it was concluded that the sulfur decreases more rapidly in the presence of ZnO. In the above accelerated vulcanizations too, the variation in the reciprocal swelling maxima with curing time is a first-order reaction, and crosslinking and decrease in sulfur are closely related processes.

The zinc salts of fatty acids were found to have a remarkable effect on the kinetics of cure accelerated by MBT plus ZnO. The rate constant of sulfur decrease is a largely linear function of the content of these salts in the vulcanizates. With equimolar addition, they have increasing effect on the rate constant of the drop of sulfur in the series: Zn-acetate: Zn-

propionate: Zn-palmitate; Zn-stearate. The addition of these salts also affects the kinetics of cross-linking.

France

Testing Symposium Schedule

Under the auspices of the Division of Plastics & High Polymers of the International Union of Pure & Applied Chemistry, a symposium on the Scientific Background of Testing Elastomers, Fibers and Plastomers is to be held in Paris, July 25-26.

President and secretary, respectively, are R. Houwink, Netherlands, and Prof. P. Dubois, 292 Rue St. Martin, Paris. The subject is to be: relationship between the physical chemistry and the testing (with special reference to standardization) of elastomers, fibers and plastomers, on the basis of their structure.

Further information can be obtained from the secretary.

Graft Polymer Papers

Among the various symposia held in connection with the Fourth Chemical. Rubber & Plastics Exhibition, in Paris. November 18-December 3, 1956. a two-day conference devoted to recent progress in copolymerization of rubber and plastics, and more particularly, in graft copolymers, attracted much attention. A number of experts from various countries presented papers, among which may be mentioned the following:

Graft Reactions by Means of Peroxide. G. Smets, University of Louvain, Belgium. Polymerization by Grafting. H. Mark.

Polytechnic Institute Brooklyn, and R. B. Mesrobian, U.S.A.

Preparation of Graft Polymers by Ionizing Radiations. M. Magat, A. Chapiro, and J. Sebban-Danon, Centre National de la Recherche Scientifique, Paris.

Structure and Properties of Graft Polymers, Y. Landler and P. Lebel, Polyplastic, Paris.

Graft Copolymerization and New Possibilities of Cross-Linking in Natural Rubber, R. Houwink, Netherlands Atomic Research Institute, Netherlands.

Distribution and Chemical Homogeneity of Grafted Polythene. A. Charlesby and M. Pinner, Tube Investments. Ltd.. England.

History of the First Experiments on Copolymerization with Natural Rubber. J. LeBras, Institut Français du Caoutchouc, Paris.

Tire Output Up

As compared with 1955 results, production of tires in France in 1956 increased by almost 10%, from 186,257 to 204,701 tons: while exports declined by almost 8.6%, from 40,316 to 36,859 tons.

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AF					Х		X		Х			
AO or AO-X					X	X	X		X			
AR or AR-F			Х		X							
BF or BG-X	X	X	X		X	X	X					
BGM or BGM-X	Х	Х		X		X						
CY					X				Х			
DI	X	X	X				X		X			
DL							X		X			
H			X		X			X	X	X	X	
LD	X	X	X	X	X	X		X				
ND or ND-X	X	X	X	Х	X	X	X	X	X	X	X	
0	X	X	X	X		X	X		X	X	X	X
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NEW MATERIALS

Cyan Blue Toner XR 55-3760

A new phthalocyanine blue pigment for the rubber, plastics. and floor covering industries has been added to the Cyan Blue Toner line of the pigments division of American Cyanamid Co.. New York, N. Y. Designated XR 55-3760, the new pigment is said to provide ease of dispersion and good strength development even under adverse conditions of milling. Its high strength, redness of shade, and resistance to heat and light make it especially applicable to rubber, plastics, and floor covering products, according to the company. The bulking properties of the pigment include a specific gravity of 1.50, a density of 12.5 lb./gal., and a bulking value of 0.080 gal./lb.

Stronger, More Heat-Stable Silastic

A new silicone rubber stock that is said to combine all the thermal stability and high dielectric properties characteristic of silicone rubber with a mechanical strength and abrasion resistance closely approaching that of conventional organic rubbers may be had from Dow Corning Corp., Midland, Mich.

Called Silastic 916, it is non-toxic, serviceable at extreme low temperatures, and easily processed, according to the company. This material, moreover, is suitable for molding, extruding. or calendering and can be hot-air vulcanized. It remains firm in the unvulcanized state, thus minimizing possible distortion of extruded shapes prior to curing. Suggested applications include oven-door gaskets, aircraft door seals, wire and cable coatings. and oxygen masks. Only pilot-plant quantities are available.

Tentative physical properties for Silastic 916 include a tensile strength in the range of 1,500 psi., a tear strength of about 200 ppi., an elongation of more than 500%, a Shore A hardness of 50-60, and a useful temperature range of from -130 to more than 500° F.

Hybond 56 Contact Adhesive

What is said to be a fast-setting, solvent-type, synthetic rubber compound designed for industrial bonding operations on highspeed production schedules has been announced by Pierce & Stevens Chemical Corp., Buffalo 3, N. Y. Called Hybond 56. it produces an odorless, non-staining bond with high load strength which is sufficiently elastic to resist shock and fatigues. according to the company.

The contact, easily sprayable adhesive eliminates the need of clamps, presses, heat-curing schedules, and other time-consuming procedures. It is suitable for most types of dissimilar lamination involving rubber, steel, aluminum, plastic laminates, fiberboards, leathers, wood, and fabric.

Hybond 56 is available in natural, red, and blue colors, the last two for convenience in determining the amount applied. Solid content of the material is 20-22%; viscosity @ 25° C. is 2.0-3.0 poises, and weight per gallon @ 25° C. is 6.7-6.9

A publication describing the adhesive and its application, Form No. B-7b, is available on request from the company.

"Thixcin E." Application Newsletter No. 35. Baker Castor Oil Co., New York, N. Y. 3 pages. A new thixotropic agent which inhibits crawling, sagging, draining, and pigment settling in polyester resins is discussed in this publication. The effect of the material on polyester viscosity is graphically represented.



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But even though our recently-doubled plant at Moundsville, W. Va., operates near capacity, every car we ship will analyze 99.9+% pure. Impurities are in the low ppm.

Our premium-quality, water-white Aniline does not demand a price premium. You can get prompt delivery "at the market" by rail, truck or inland waterway from National Aniline's well-located plant at Moundsville (just south of Wheeling).

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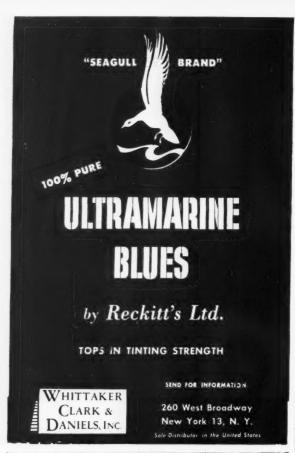
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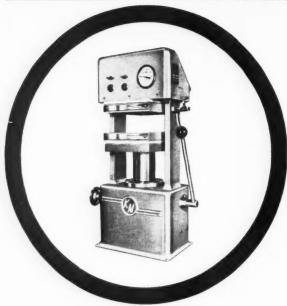
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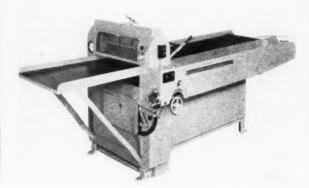
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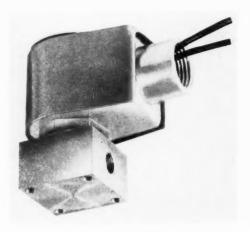
NEW EQUIPMENT

Automatic Stock-Cutting Machine

A new automatic stock-cutting machine for rubber molding stock and soft plastics is being offered by Heidrich-Nourse Co.. Los Angeles, Calif. Designated Model AH-2, the machine has an all-hydraulic actuation and features a guillotine-type knife and an automatic hitch feed. Length between cuts may be set up to 36 inches. The machine is said to provide safe, accurate, and automatic measurement and cutting of sheet stock to 1½ inches in thickness. It will handle stock to 24 inches in width at speeds up to 100 cuts a minute. A similar unit, Model AH-3, has a 36-inch-wide belt.



Heidrich-Nourse AH-2



ASCO Solenoid Valve

Solenoid Valves for Liquid CO2 Control

A two-way solenoid valve for cooling applications using liquid CO₂ has been placed on the market by Automatic Switch Co., Orange, N. J. Dubbed Bulletin 8264 valves (after the catalog number), they are designed for low-temperature tumbling barrels, environmental test chambers, and other cooling applications where constant temperature control is required. The valves have stainless steel, angle-type bar stock bodies and Teflon disks for tight shut-off on pressures up to 1,000 psi. Parts in contact with the fluid are either stainless steel or Teflon.



You'll find Nevastain B is a superior non-staining antioxidant at lower cost

Nevastain B is an excellent non-staining, non-discoloring antioxidant developed especially for rubber manufacturers who prefer an antioxidant in the flaked form for greater convenience in compounding operations. It is shipped in sturdy 50-pound bags for easy weighing and handling. In some instances, Nevastain B can replace products three times higher in cost, and it has proved itself to be readily compatible with synthetic and natural rubbers, has shown no indication of blooming at more than double normal dosage,

and does not interfere with the rate of cure. Write for a sample and the Technical Service Report on Nevastain B.

Neville Chemical Company, Pittsburgh 25, Pa.

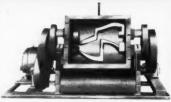
Resins—Coumarone-Indene, Heat Reactive, Phenol Modified Coumarone-Indene, Petroleum, Alkylated Phenol ● Oils—Shingle Stain, Neutral, Plasticizing, Rubber Reclaiming ● Solvents—2-50 W Hi-Flash, Wire Enamel Thinners, Nevsolv.



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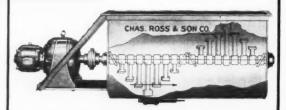






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Heavy Duty Change Can Mixers

CHARLES ROSS & SON COMPANY, INC.

Dept. R. 148-156 Classon Ave., Brooklyn 5, N. Y.

The valves are said to mount in any position without affecting their operation.

Both direct-injection and remote-injection types of construction are available. The direct-injection type has a valve body provided with four mounting holes and is bolted directly to the inner lining of the refrigerated cabinet. Piping and reduced size orifice on the outlet side of the valve are done away with. This direct-injection construction is said to eliminate the possibility of any premature expansion of the liquid CO₂ within the valve, which normally causes valve failure.

The remote-injection type of valves are provided with 1/8-inch tapped pipe connections at inlet and outlet. Depending on cooling requirements, it is sometimes necessary to use a reduced orifice nozzle on the outlet side of the valve, the company says.

Pressed steel, U. L.-approved explosion-proof, or watertight solenoid enclosures are also available. All enclosures have standard ½-inch threaded conduit connections and can be rotated a full 360 degrees.

Bench-Model Rubber, Plastic Slitter

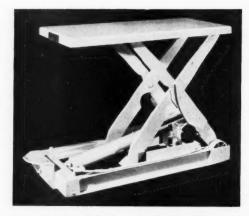
A single-operator, benchmodel slitter that takes rubber or plastic parent rolls up to 18 inches wide and slits as narrow as 352inch has been placed on the market by Doven Machine & Engineering, Inc., Chicago, Ill. Designated No. R-18, the unit can handle sponge rubber rolls on sheets up to 36-inch thick, hard rubber up to



R-18 slitter in operation

1/4-inch thick, and heavy-weight 0.040 plastic. The slitter's single rewind principle permits rewinding with or without spacer, preventing fusing or interleaving, the company says.

Standard equipment on the machine is a cross-cut attachment which eliminates the need of punch-press equipment for swatching. A foot-switch starts or stops operations. The unit loads, threads, slits, and rewinds from the top. The 20-inch-high slitter requires a floor space of 30 by 40 inches. Complete with three-speed change motor, the R-18 can be plugged into any 110 AC light socket.



Southworth's Strongback lift table

Skid Lift Table

A lifting device designed to elevate skid or palletized loads to correct feeding, working, or positioning heights for a variety of machine, process, or assembly operations has been introduced by Southworth Machine Co., Portland, Me. Dubbed Strongback lift table, it has a 24- by 52-inch platform, a capacity of 4,000 (Continued on page 122)

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Within the first day of startup, full width nylon tire cord processed in this 30-yard-perminute, 14,000-pound-tension IOI Rollevators Oven*, was made into aircraft tires meeting all qualification tests.

♠ The Rollevators roll automatically moves up and down within the oven, in direct relation to line speeds. Thus, at any line speed, heat-exposure time of the nylon is held constant at a constant temperature setting and at constant tension.

Rollevator® Oven* hot stretches nylon tire cord at constant optimum temperature, constant time and constant tension, at variable line speeds

The IOI Rollevator. Oven* is the answer to more uniform hot stretching of nylon with greater production efficiency. Simple and automatic in operation, it practically eliminates costly shutdown and repair time. When the line is stopped the Rollevator. roll automatically lowers out of the heat zone, eliminating the need for quick cool purging of the oven

and the time and expense involved in reheating the oven when starting up again. Its low operating cost combined with low initial cost assures you of lower production cost. An IOI sales engineer will be glad to give you complete information about the Rollevator. Oven* and to discuss your requirements for any system from 3 to 100 yards per minute.

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NEW PRODUCTS



Robbins Ezy-Clean Rubber Stair Tread

Skid-Proof Rubber Stair Tread

A new rubber stair tread has been introduced by Robbins Floor Products, Inc., Tuscumbia, Ala. Called Ezy-Clean rubber stair tread, it is designed with a thickness of $\frac{5}{16}$ -inch at the heaviest wearing point, tapering to $\frac{3}{16}$ -inch at the rear to match the standard $\frac{3}{16}$ -inch rubber tile on stair landings. Embodying a skid-proof diamond design, the tread is available with roundnose or square-nose edging molded to fit over the step in one piece.

Six color styles are being offered to match the company's Micro-Finish color tile.

Goodrich Rubber Household Gloves

Two new rubber household gloves have been added to the Klingwell glove line of the sundries division of B. F. Goodrich Industrial Products Co., Akron, O. The first, dubbed Plushlined, is coral-colored and made of pure latex, with a lining of white plush for insulation against hot and cold water and for absorption of perspiration.

The second, called Neoprex, is made of turquoise-colored neoprene, with a pure latex lining and is resistant to grease, oil, and detergents.

The fingers and palms of the new gloves are roughened with ridges. Sizes are small, medium, and large.

Armstrong Asbestos/Rubber Gasketing

A group of asbestos fiber gasketing materials that are said to be extremely flexible, easily applied, and very durable has been placed on the market by the industrial division of Armstrong Cork Co., Lancaster, Pa. Designated Accopac, they are available with binders of styrene, nitrile, or chloroprene rubbers. The gasketing is said to show perfect sealing performance with minimum bolt torque loss where flange temperatures are up to 500° F. and internal liquid pressures are up to 500 psi.

According to the company, Accopac gasketing has such characteristics as toughness and flexibility, ease of die-cutting because of the absence of loose fibers, and unusual compressibility which allows for perfect sealing under lower bolting pressures than those required for hard compressed asbestos sheets. The fibers are coated with a rubber binder by a patented "beater-saturation" process in which special saturants are added to a water slurry before the composition is formed.

April.



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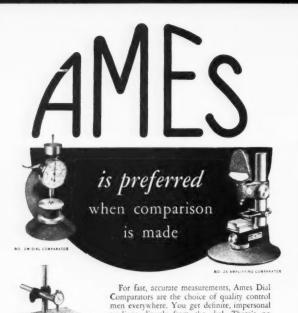
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ing resilient materials such as rubber, paper, etc., and for measuring non-yielding materials such as sheet metal, glass and plastic. Write



Lighter Dayton Tubeless Truck Tire

A five-rib tubeless truck tire, claimed to be the lightest in weight yet produced for highway service, has been announced by The Dayton Rubber Co., Dayton, O. The 11-22.5, eight-ply 12-ply rating tire has Super-Cordura rayon cord construction and is said to be stronger than conventional 12-ply rated tires and lighter than premium-priced nylon tubeless tires of the same size and ply rating. The net result is a tire with greater payload capacity and extra mileage, Dayton declares.

Rubbermaid Kar-Rugs

New automotive rubber mats in an array of "confetti" colors have been added to the line of The Wooster Rubber Co., Wooster, O. Dubbed Rubbermaid Kar-Rugs, they show a sprinkling of varied hues against solid backgrounds of blue, gray, black, or tan. The mats feature a diamond-like top surface and molded buttons on the back to provide ventilation and to eliminate slippage. These mats fit all makes of cars and are produced for both front and rear floor surfaces.

Duroil Air Drill Hose

A pneumatic drill hose for heavy-duty use in quarries, mines, road construction, and other types of service requiring a light, flexible, yet strong hose has been introduced by Hewitt-Robins, Inc., Stamford, Conn. Called Duroil air drill hose, it is constructed of an oil-resistant nitrile rubber tube, a braided rayon cord carcass, and a natural rubber cover which has a tensile strength of 2,000 psi. The hose is capable of resisting the tearing, gouging, and impact abuses common to air-drill hose service, the company says. Duroil is available in 500-foot reels in diameters of ½2-, ¾4-, and one inch.

Skid Lift Table

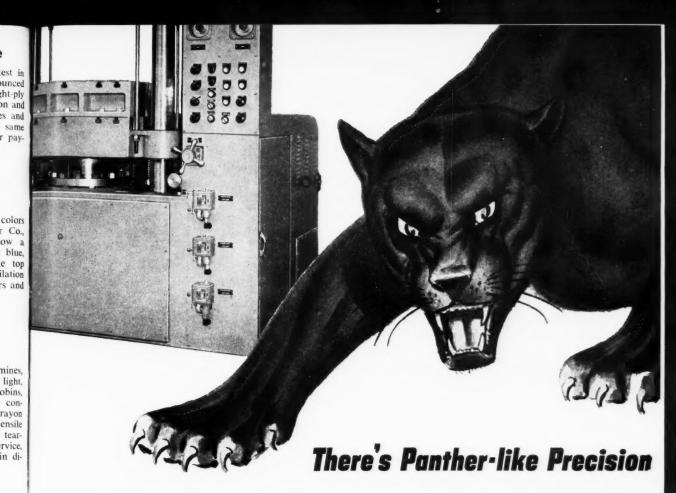
(Continued from page 118)

pounds, and a lift of 30 inches, with hand or foot switches giving the operator the opportunity of effecting a lift of 37¼ inches in a single stage. Power is supplied by a ½-hp. single-phase. 115-volt AC, 60-cycle, 1,725 rpm. motor. Its scissor-type lift is controlled by an electro-hydraulic pump with built-in relief and solenoid valves. It has one pair of fixed wheels, a pull plate, and a detachable dolly or skid spotter. Collapsed height of the Strongback lift table is 7¼ inches.

Birdsboro 2,200-Ton Hydraulic Press

A new 2,200-ton multiple-opening water-hydraulic press for the production of laminated products has been placed on the market by Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa. Said to be of rigid construction to eliminate sway and minimize deflection, the steam-platen press has side plates keyed and bolted to the main cylinder and to the top platen. A multiple-opening elevator attached to the front of the press permits loading every other opening during the pressing cycle. This design reduces the time required between pressing cycles and allows the operator sufficient time to load and unload the elevator during the press cycles, according to the company.

The press also features a special roller suspension design which is said to safeguard against injuring the loading and steam plates. Rollers within the press area are retracted from under the loading plates just prior to closing the press, eliminating the possibility of catching and damaging the plates in the closing process. The new Birdsboro press has 10 openings and 38-by 26-inch steam plates. The unit is driven by two 34-inch rams at an operating pressure of 2,500 psi. of water.



in the AUTOMATIC Molding Cycle of this Erie Press

If you're molding critical materials, this self-contained Erie Foundry Press will give you accuracy in controlling tonnages and pressing time for every heat. It has a separate timer on both the 200-ton main ram and the 55-ton transfer cylinder. The press is completely flexible as to tonnage, speed, and position. Fast advance—up to 270" per minute; fast return—up to 240" per minute; with speeds provided by two double-acting cylinders. In addition, the bottom hydraulically-operated knock-out mechanism and mechanical top mold knock-out make short work of stripping.

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And...you'll get "quick-as-a-panther" advice and service from us if you want more details on this press... or other Erie Foundry presses. Just call or write.



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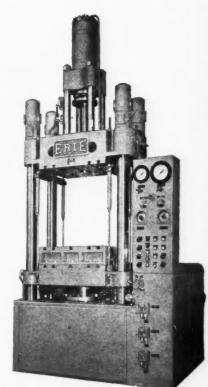
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TECHNICAL BOOKS

BOOK REVIEWS

"Chemistry of High Polymer Degradation Processes." By Norman Grassie. Interscience Publishers, Inc., New York, N. Y., and Butterworths Publications, Ltd., London, England. Cloth, 6 by 9 inches, 335 pages. Price \$6.50.

With the rapid growth of the synthetic polymer industry a very real need has arisen of a thorough understanding of the processes responsible for polymer degradation. This monograph will be a valuable tool for anyone engaged in this field. The book brings together a vast amount of scattered information with abundant references and attempts to appeal to the industrial chemist as well as one engaged in the more theoretical aspects of polymer chemistry.

A short introduction with a discussion of experimental considerations in the study of degradation reactions comprises the first chapter. The second chapter is concerned with the depolymerization of polymers in vacuo. Initiation by photochemical means as well as the more widely used thermal initiation is included. A discussion on the rate constants for these processes is also given. Polymerization-depolymerization phenomena are also taken up as well as degradation reactions that are induced mechanically.

Succeeding chapters deal with hydrolytic degradation of polymers and random chain-scission reactions in general. The statistics of the random scission process are presented. The oxidation of both low molecular weight olefins and polyolefins is reviewed. Such topics as the elementary steps in auto-oxidation, the effect of antioxidants, and the rate constants for initiation, propagation, and termination for a series of olefins are given full treatment. Also included is a detailed account of cross-linking and chain scission which accompany the oxidation of polyolefins and the present techniques that are available for measuring these reactions.

The sulfuration and the ozonization of hydrocarbon polymers are reviewed. Although the sulfuration (vulcanization) of unsaturated hydrocarbon polymers yields a useful product, it is classified as a degradation reaction by the author. The explanation given is that sulfuration is to be considered as a natural extension of oxidation. In a broad sense this explanation is undoubtedly true; in a practical sense, however, many will view this classification with some surprise. A general account is presented of the large amount of published work on the chemistry of sulfuration of low molecular weight (model) olefins. A brief section on the ozonization of unsaturated polymers is also included in this chapter.

The last chapter is a treatment of non-chain scission reactions. This type of reaction generally consists of the chemical reaction of reactive substituents on a backbone hydrocarbon chain. The reaction of chlorine in polyvinyl chloride is given extensive treatment. The last section of the chapter covers the ionic reactions of rubber.

The figures and drawings are well done: the book contains very few typographical errors and should prove of value to those in all branches of polymer science.

A. G. VEITH

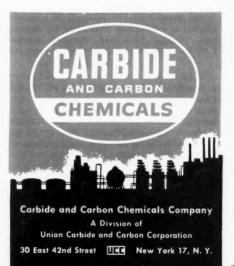
"Rubber Chemicals." J. van Alphen, Rubber Stichting, Delft. The Netherlands. Elsevier Publishing Co., Amsterdam, The Netherlands. Sole distributor for the United States and Canada, D. Van Nostrand Co., Inc., New York, N. Y.; for the British Commonwealth except Canada, Cleaver-Hume Press, Ltd., London, England; and for Germany, Berliner Union, G.m.b.H., Stuttgart, Germany, Cloth cover, 6 by 9 inches, 164 pages, Price, U.S.A., \$5.

This book has been compiled in an attempt to meet the need of a simple guide to the extensive and rapidly growing field of rubber chemicals on a worldwide basis, according to the preface



FLEXUL PLASTICIZERS DOP, 426, 810, 10-10, and CC-55

Each one has its place in plastics, and each one rates a listing on your books. These phthalates offer excellent heat and light stability, good resistance to water extraction, and excellent electrical properties. In addition, these five Flexol Plasticizers allow you to select the phthalate with the proper volatility, solvent power, and dispersing action for your use. Check these phthalates before you consider any other plasticizer for your vinyl plastics or nitrocellulose lacquers.



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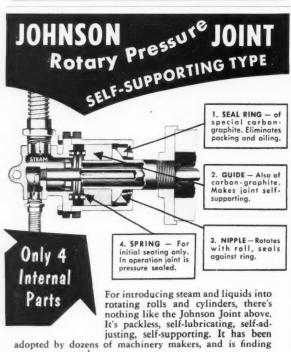
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written by R. Houwink, former general director of Rubber Stichting. The manuscript was originally prepared by J. van Alphen, at the request of H. C. J. de Decker, director of research for internal use in the laboratories of Rubber Stichting. W. J. K. Schonlau and M. van den Temple and others at the Dutch rubber research institute assisted in the work.

The authors restricted themselves to accelerators, activators, antioxidants, blowing agents, peptizing agents, retarders, and vulcanizing agents, with emulsifying agents and carbon blacks also listed according to types. For the first major groups the chemical names are given together with a brief description of each material and its properties. The trade names and the suppliers in the various countries complete the discussion for each material. The trade names for a given compound are listed in alphabetical order, and an alphabetical index provides a means to find those materials of which only the name is known,

Although this book is not a complete listing of all compounding ingredients used by the rubber industry, it should be of general value both in this country and abroad. Its usefulness in the United States, however, may be reduced by the large number of compounds listed that are available outside this country. For example, the total number of accelerators listed is about 155, of which half are available abroad. Also, the author's preoccupation with emulsifying agents, 432 of which are listed, may not be of great value to the rubber compounder in this country.

NEW PUBLICATIONS

"The Du Pont Elastomers." E. I. du Pont de Nemours & Co., Inc., elastomer chemicals department, Wilmington, Del. 16 pages. The company's neoprene and Hypalon synthetic rubbers are described in this illustrated brochure. The physical and chemical characteristics of the two elastomers are given, and a comparison is made with other rubber materials.

"Kralistic Extrusion." E. J. Trunk. Bulletin No. 1. Naugatuck Chemical Division, United States Rubber Co., Naugatuck Conn. 16 pages. The techniques involved in the extrusion of the company's resin-rubber compounds are discussed in this illustrated booklet. Types of applicable screws, dies and pins, screens, pipe sizing, and other equipment, as well as operating temperatures and common difficulties and corrective measures, are detailed.

"Symposium on Minimum Property Values of Electrical Insulating Materials." ASTM Special Technical Publication No. 188. American Society for Testing Materials, Philadelphia, Pa. 48 pages. Price, \$1.75. Seven papers originally presented at a meeting of ASTM Committee D-9 in February, 1956, have been reprinted in this booklet. The intention of the symposium was to report progress in establishing procedures for determining the minimum property values of electrical insulating materials which would enable designers to predict safety fac-

"Hycar Latex Newsletter." Issue No. 15. B. F. Goodrich Chemical Co., Cleveland, O. 4 pages. This issue reports on the comparatively small amounts of Hycar latex required to modify thermosetting resins in finishes for developing crease resistance and wrinkle recovery in cotton fabrics. As little as 2.5 parts of Hycar latex are said to be effective. Recipes and test data are given, illustrating the investigation.

Publications of R. D. Wood Co., Philadelphia, Pa.:

"Hydraulic Presses for the Rubber and Belt Industry." 4 pages. Specifications of some of the company's hydraulic presses for curing operations, molding operations, and belt vulcanizing are given in this illustrated bulletin.

"R. D. Wood Platens-the Perfect Working Surface for Processing Plastics, Wood Products, Rubber." The company's methods for manufacturing heat-and-pressure-applying platens are described and illustrated in this booklet.

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Does chelation actually represent a new kind of chemistry? Are the possibilities as exciting as many seem to think? This series endeavors to answer these—and many other—pertinent questions on this fascinating subject. It is hoped chemists, engineers and purchasing agents alike will find these answers helpful. Now



The Chemistry of Chelation: Part II

Versene and Versenol Series · Descriptions and Uses
A measure of Value · A Suggestion

To review in capsule form: Part I introduced chelation, offered examples of typical chemical reactions, applications, and discussed future possibilities. You will remember that a chelating agent is defined as a chemical which surrounds metallic ions with a multiple-ring structure that keeps the metal chemically inactive and holds it in solution. The applications in industry are many—and new ones are being found almost daily. That, of course, brings us to another consideration: different chelating agents for different uses.

VERSENE® AND VERSENOL®

Chelating agents are commercially available from Dow as 15 different products-all based on aminocarboxylic acid derivatives. Among these, wide spectrum performance is shown by two series of products. The Versene series of products (Versene® 67, Versene 100, Versene Powder, Versene Beads, Versene 9 and Versene Acid) is based on EDTA* and the sodium salts of this material. The Versenol series (Versenol® 120, Versenol Powder and Versenol Beads) consists of various physical forms of Na₃ HEDTA**. The Versene series, except for Fe+++ in the alkaline pH range, is generally the stronger series of the two (more completely chelates the last traces of metal). The Versenol series is notably stronger for Fe+++ in the mildly alkaline pH range and is usually cheaper on a performance basis if the consumer can tolerate the weaker chelate structure. Versene is the strongest, most stable commercially available chelating agent. It is the one with the greatest number of successful applications.

DESCRIPTIONS AND USES

Here are three Dow chelating agents together with their descriptions and uses:

Versene 100 is a concentrated aqueous solution of a technical grade of the tetrasodium salt of EDTA... widely used in textile processing, detergent formulations and metal cleaning.

Versene Acid is a dry form of EDTA technical. It is used in many operations as a raw material for the preparation of various derivatives, such as metal chelates, salts (K, NH₄), esters and many others.

*Ethylenediaminetetra acetic acid

**Trisodium salt of N-hydroxyethylethylenediaminetriacetic acid Versenol 120 is a concentrated aqueous solution of a technical grade of Na₃ HEDTA. It is also very valuable to detergent, textile and metal-cleaning processes.

Naturally these three specific agents are not the answer to every problem. That's the reason for the many other Versene products, to be discussed in Part III.

A MEASURE OF VALUE

A measure of the broad performance capacity of a chelating agent can be obtained from its chelation value—determined on a reference metal. Calcium is used as the reference metal under the standard test proceedure accepted by the industry. Dow prefers this "performance basis". It specifies more clearly what chelating agents actually accomplish than such terms as "% solids" and "% active". Consequently, the "100" in Versene 100 means that one gram of this product will chelate 100 milligrams of calcium carbonate in accordance with the standard test procedure. By the same token, one gram of Versene 67 will chelate 67 milligrams, and so on.

A SUGGESTION

Two closing thoughts: Dow wants to help in any way possible to further develop the applications for chelation. Also important, Dow would like to hear from you—your thoughts, reactions, suggestions. Please inquire about any problems or ideas you may have. Information or actual technical assistance will be forthcoming promptly. Write, on your company letterhead, to Technical Service and Development, Dept SC 912N-2, THE DOW CHEMICAL COMPANY, Midland, Michigan.

THE NEXT TOPIC IN THIS SERIES

PART III
August

Specific chelating agents for specific applications. Polymerization of synthetic rubber (development of Versene® Fe-3 for controlled release of traces of metal used as catalyst—improvement in process that results in Latex stabilization).

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Publications of the British Rubber Producers' Research Association, Welwyn Garden City, Herts., England:

No. 242. "The Determination of Acid Strengths of Organic Hydroperoxides." D. Barnard, K. R. Hargrave, and G. M. C. Higgins. 5 pages. The relative acid strengths of several organic hydroperoxides and alcohols were determined by an infrared spectroscopic study of their association with *cyclohexyl* methyl sulfoxide. The equilibrium association constants obtained for a series of hydroperoxides parallel the relative acidities predicted by a kinetic method and enable absolute pK_s values to be derived for those hydroperoxides not amenable to conventional dissociation methods. ∞ -Cumyl hydroperoxide is an exception to this correlation; the anomaly is traced to the intramolecular interaction of the hydroxyl group with the aromatic nucleus.

No. 243. "Oxidation of Organic Sulfides. Part VII: The Mechanism of Autoxidation of But-2-enyl Methyl Sulfide. Methyl I-Methyl-but-2-enyl Sulfide, and n-Butyl Methyl Sulfide." L. Bateman, J. I. Cunneen, and J. Ford. 9 pages. The products of autoxidation of the sulfides named in the title were identified and estimated quantitatively. The relative proportions of sulfoxide, water, and dimethyl disulfide vary widely. The yield of sulfoxide is independent of the extent of oxygen absorption in the saturated sulfide, but decreases as reaction proceeds with the allylic sulfides, markedly so with the dimethylallyl methyl sulfide. These and related observations can be correlated on the basis of a reaction mechanism outlined in the report.

No. 244. "Heat-Sensitization of Natural Latex: Recent Developments." E. G. Cockbain. 5 pages. An account is given of the use of zinc ammonium salts, polyvinyl methyl ether (PVME), and polyoxypropylene diols (e.g., Oxirane HS 35/40) as heat-sensitizing agents for natural latex. In each case, factors controlling the gelling action of the agents are considered. The use of PVME in dipping processes and Oxirane HS 35/40 in latex foam applications is discussed.

No. 245. "Superior Processing Rubber." H. C. Baker. 20 pages. The author has divided the paper into three main sections. In the first, an account is given of some of the principal advantages of superior processing (SP) rubber over normal RMA grades of sheet and crepe. Following is a description of its development, preparation, and the reason for the superior processing characteristics as indicated by electron micrographs. The final section consists of data obtained in a laboratory evaluation of the material.

No. 246. "Mastication of Rubber. Part IV: Polymerization of Vinyl Monomers by the Cold Mastication of Rubber." D. J. Angier and W. F. Watson. 16 pages. The rupture of natural and synthetic rubber molecules into free radicals by the shear imposed during cold mastication under nitrogen initiates the polymerization of monomers incorporated in the rubber. Experimental results on the polymerization of a range of monomers is reported. The polymer formed is mainly attached to the rubber, forming with it either a soluble interpolymer or a two-component gel. depending on the monomer used. Results on the copolymerization of two monomers are also presented and interpreted.

"Thiokol Butyl Rubber Developments." Thiokol Chemical Corp., Trenton. N. J. This kit contains latest information on market developments in butyl rubber; a technical bulletin on evaluation of butyl accelerators; a study of carbon black in butyl rubber; a types-and-properties chart on butyl; and a sketch of Thiokol's butyl sales and technical organization.

"Fundamentals of Thermoplastic Extrusion." Product Information Bulletin No. 1029. Monsanto Chemical Co., plastics division, Springfield, Mass. 31 pages. This illustrated manual on thermoplastic extrusion gives a detailed discussion of extruders, screws, dies, post-extrusion equipment, the theory of melt extrusion, isothermal theory, screw and die characteristic curves, the major factors affecting screw characteristics, and adiabatic theory.

"Industrial Ovens and Dryers." Loss Prevention Bulletin No. 14.15 Factory Mutual Engineering Division, Associated Factory Mutual Fire Insurance Cos., Norwood, Mass. 40 pages. Price, \$1. The causes and prevention of fires and explosions in industrial ovens and dryers constitute the subject of this pamphlet. Many illustrations amplify the text.

Philchem

RUBBER CHEMICALS NEWS ITEM NO. 6



Laboratory investigations show that optimum performance of Bag-O-Matic bladders is obtained with Philblack E reinforcement. With 50 parts Philblack E, incorporation of 10 parts of Philprene 1500 imparts excellent stability to the vulcanizate during exposure in open steam. Essentially equal performance can be obtained with 60 parts Philblack E in the absence of other additive rubbers to help retard reversion. Typical test data for these stocks are cited in the table at right.

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Philprene 1500	_	10	_	
Neoprene GNA	10	_	_	
Philblack E	50	50	60	
Forum 40	6	6	6	
Zinc Oxide	5	5	5	
Petrolatum	2	2	2	
GMF	2	2	2	
Red Lead	8	8	8	
Sulfur	2	2	2	

SUMMARY OF PHYSICAL PROPERTIES

Mooney, ML-4-212°F	85	88	107
Ultimate Tensile, psi	2,180	2,340	2,450
Ultimate Elongation, %	465	365	350
Shore A Hardness	66	69	69
ASTM Compression Set, %	21.5	19.1	19.5

AGED 96 HOURS IN OPEN STEAM AT 328°F

		T	T
Ultimate Tensile, psi	1,000	1,575	1,610
Ultimate Elongation, %	300	340	310

3" x 3" x ½" blocks aged 600 hours in open steam at 328°F

Resistance to Surface Oxidation of Block	Fair	V. good	V. good
Durometer Change of Block	+3	+6	+1

Steam pressure released daily and samples examined. None of the samples developed ply separations or blows. Surface oxidation was evaluated by ease with which surface could be scratched with knife.



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Publications of Godfrey L. Cabot, Inc., Boston, Mass.; "Vulcan 9 in Butyl Curing Bladders." I. D. Bolt. Technical Service Laboratory Bulletin No. GD-18, 3 pages. Vulcan 9, an SAF black, is compared with the company's ISAF, HAF, FEF, and EPC blacks for reinforcing butyl curing bladders

in automatic tire vulcanizers, and is shown to be superior. "Vulcan XC72." T. D. Bolt, B. B. Boonstra, K. P. Seltzer. Technical Report RC-102. 7 pages. Vulcan VC-72, an extraconductive furnace black for anti-static and highly conductive rubber and plastic compounds, is discussed in this booklet. Its performance in natural rubber and SBR is compared with that of other blacks.

"Dayton Poly-Koolfoam." The Dayton Rubber Co., Dayton, O. 4 pages. A general discussion of the properties and uses of the company's polyurethanes is contained in this illustrated file folder. An eight-page data section comparing the properties of Poly-Koolfoam and natural rubber latex foam is also included.

"Testing of Weighing Equipment." National Bureau of Standards Handbook H37. Government Printing Office, Washington, D. C. 184 pages. Price, \$1.25. This is a reprint of one of a series of handbooks designed to present in compact form comprehensive information relative to weights and measures supervision. Types of scales and weights are also described as well as principles of their operation and methods for their inspection and test.

"Silicones." CDS-97. General Electric Co., silicone products department, Waterford, N. Y. 8 pages. This condensed catalog discusses more than 115 applications for silicones and lists specialized literature covering product and application data.

"Neoprene Latex Type 750." R. O. Becker. Report No. 57-3. E. I. du Pont de Nemours & Co., Inc., elastomer chemicals department, Wilmington, Del. 8 pages. The physical properties and techniques for general and specific compounding of Neoprene Latex Type 750, a new general-purpose neoprene latex said to produce films much like those of natural rubber in softness and pliability, are discussed in this booklet.

"Enjay Butyl-the Versatile General-Purpose Synthetic Rubber." Enjay Co., Inc., Butyl Division, New York, N. Y. This brochure, intended for design engineers, summarizes the properties and applications of Enjay Butyl. Applications are pictured, and the physical and electrical properties of the rubber are detailed.

Publications of Office of Technical Services, United States Department of Commerce, Washington, D. C .:

"The Theory and Operation of a Dynamic Tester for Evaluating Package Cushioning Material." PB 121692. 42 pages. Price, \$1.25. Dynamic performance of a package cushioning material frequently varies from predicted values derived from static performance, particularly in the cellular-type materials such as the new polyurethane foams. Because of the dynamic variance it was desired to revise a military specification for general cushioning from a basis of static performance to one of dynamic performance. A. D. Klingenberg, the author, describes test procedures and a data reduction method.

"Research and Development of Abrasion Resistant Treatments for Dacron Webbings." PB 121496. 61 pages. Price, \$1.75. The use of a silicone and catalyst emulsion for producing superior resistance to abrasion in Dacron parachute webbings is described in this report of research done for Wright Air Development Center. The webbing met specifications for flexibility at -65° F. A new method for measuring the flexibility of treated Dacron and nylon is discussed.

"Effect of Impact Speed on the Brittle Temperature of Elastomers." PB 121502. 20 pages. Price, 50¢. Investigations which led to recommended revisions of an ASTM test of impact speed-brittle temperature relations for elastomers are described in this report of Army Ordnance Corps. research. Among recommendations made was a change in impact speed in ASTM D 746-54T from 6.5 fps. to 12 fps. for improved reproducibility of brittle temperatures.

Apri



Defoaming latex, for example. Dow Corning silicone defoamers eliminate bubble trouble during processing of synthetic latices. Economical, too, because small amounts effectively control the most violent and persistent foamers.

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MARKET REVIEWS

Latex

Natural latex prices continued to fall during the February 16-March 15 period, but consumers were hard put to meet their demands, since a heavy drain on Malayan supplies has been going on for the past three months. Added to this difficulty was the continuing hoarding by Indonesian producers due to the serious political disturbances that are besetting that country. Trade sources said that in view of these negative supply conditions it was remarkable that natural latex prices did not increase.

Synthetic latices during the period took up some of the slack provided by the shortage of natural latices, but basic demand was still behind that of the same

period last year.

Prices for ASTM Centrifuged Concentrated natural latex, in tank-car quantities, f.o.b. rail tank cars, ranged during the period from 39 to 41¢ per pound solids. Prices of synthetic latices were steady at about 22 to 32¢ for SBR; 37 to 47¢ for neoprene; and 44 to 54¢ a pound for N types.

Final December and preliminary domestic statistics for all latices were reported by the United States Department

of Commerce as follows:

(All Figures in Long Tons, Dry Weight)

Pro- duc- tion	Im-	Con- sump- tion	Month- End Stocks
0	6,661	6,666 7,038	12,262 11,512
7,101 7,228	42	5,399	7.327
967 905	0	701 812	1.421
		012	4 4 4 5
1.012	0	710	2.017 1.605
	duction 0 0 7,101 7,228 967 905	duction ports 0 6,661 7,101 42 7,228 967 0 905 0 1,012 0	duction Imports sumption 0 6.661 6.666 0 7.101 42 5.399 7.228 6.788 967 0 701 905 0 812

Synthetic Rubber

Demand for SBR during February and March eased somewhat, according to industry reports, as large tire companies dipped into their heavy SBR stocks accumulated during the last quarter of 1956. April demand for the synthetic rubber is expected to rise as both large and small rubber companies come into the market.

Consumption of all types of synthetic rubber in the short month of February amounted to 77.527 long tons, as compared with January's consumption of 86,539 long tons. Of the total new rubber consumed in February synthetic rubbers accounted for

62.76%, relatively little change from the 62.16% ratio recorded for January. The Rubber Manufacturers Association, Inc., also estimated February production of synthetic rubber at 83.215 long tons, of which 65.688 long tons were SBR.

The automotive industry now expects to sell between 6 and 6½ million passenger cars during 1957, according to the *Natural Rubher News*. The optimistic forecast is based on a January-February sales rate of

18,700 units a day.

Predictions of record rubber product sales for 1957 are already beginning to appear. Chester J. Noonan, vice president of United States Rubber Co., said he expected rubber industry sales to reach a record volume of \$6 billion during 1957, compared with \$5½ billion in 1956. E. J. Thomas, president of The Goodyear Tire & Rubber Co., said his company should show record sales and earnings for 1957. Other sources predict tire shipments will rise about 6% over 1956 figures.

All of these estimates and predictions would seem to indicate a rising market for synthetic rubbers of all types.

Natural Rubber

Natural rubber prices staged a mild recovery during the February 16-March 15 period, the first such upswing since mid-December. Political troubles in Indonesia. Thailand, and the Near East combined to harden the market. Another factor was provided by the continuing Egyptian delay in opening the Suez Canal and the announcement that Egypt would consider no alternative to its insistence that all Canal tolls be paid to it alone, a position the United States opposes. Increased Russian and Chinese buying in Malaya also helped boost prices.

Buying interest in the United States, however, was at the lowest level it has been for almost a year. On the New York Commodity Exchange, for example, a total of only 17,710 tons was traded during the period under consideration. It was evident that American manufacturers were maintaining a cautious attitude. Detroit especially was watchful. March automotive sales usually provide the key to the volume of turnover until mid-summer, and these were being evaluated as a guide to further operation schedules. Rubber purchases, therefore, may pick up during April.

Statistically, on the New York Commodity Exchange 17,410 tons of rubber were traded in the Rex Contract; 300 tons were traded on the Standard Contract. There were 19 trading days during the

February 16-March 15 period.

Week-end closing Commodity Exchange future prices for the Rex Contract follow:

	Ri	EX CON	TRACT		
	Jan. 25	Feb.	Mar.	Mar.	Mar. 15
July Sept Nov	31.80 31.75 30.90 30.60 30.30	30.10 30.14 29.85 29.60 29.40	30.90 31.00 30.80 30.65 30.40	30.90 31.12 30.90 30.70 30.55	31.60 31.80 31.55 31.26 31.05
Jan May Total		29.10 28.85	30.25 30.10	30.40 30.25	30.85 30.65
weekly sales, tons	8,360	3,480	5,190	3,940	4,800

On the physical market, RSS #1 began the period at 29.75¢ a pound, according to Rubber Trade Association Sellers' prices, going to a period-high of 32.00¢ on March 13. RSS 1 averaged 30.39¢ during the period, which it had also averaged during the entire month of February. The grade averaged 31.37¢ during the first half of March. Average February monthly spot prices for representative grades were as follows: RSS #3. 29.95¢; #3 Amber Blankets. 27.13c; and Flat Bark, 20.36c. There were only 18 trading days during February.

NEW YORK PHYSICAL MARKET WEEK-END CLOSING PRICES

		Feb.			
RSS; #1	31.25	30.25 30.00 29.88	30.75	31.00	31.50
Pale Crepe #1 Thick Thin	37.75		36.75	36.50	36.75
#3 Amber Blankets Thin Brown		27.00			
Crepe Standard Flat	27.75	26.25	27.75	27.50	28.25
Bark	20.63	20.25	21.50	21.25	21.88

Reclaimed Rubber

The volume of business continued low in the reclaimed rubber market during the February 16-March 15 period, according to trade sources. The traditional spring pickup is being awaited by the industry.

A fire destroyed the entire plant, offices, and laboratory of Pequanoc Rubber Co.. Butler, N. J. The company has transferred its office activities to the plant of American Hard Rubber Co. in Butler, its parent company. Its new mixing plant in Tallapoosa, Ga., is expected to be in operation by May 1.

Reclaimed rubber prices remained steady over the period.

RECLAIMED RUBBER PRICES

Whole tire: first line	\$0.11
Fourth line	.0975
Inner tube: black	.16
Red	.21
Butyl	.14
Pure gum, light colored	
Mechanical, light colored	.135

The above list includes those items or classes only that determine the price basis of all derivative reclaim grades. Every manufacturer produces a variety of special reclaims in each general group separately featuring characteristic properties of quality, workability, and gravity at special prices.



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Ernest Jacoby & Company, Inc., Boston, Mass. * Herron & Meyer of Chicago, Chicago, Illinois * In Canada: St. Lawrence Chemical Company, Ltd., Montreal and Toronto

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Scrap Rubber

Dullness characterized the scrap rubber market during the February 16-March 15 period. Suppliers mainly confined their activity to filling mixed auto tire orders for February and March shipment to Naugatuck. Trade sources said the movement of scrap to Buffalo was beginning to show some improvement.

Period-end prices of scrap rubber grades, unchanged from last month, follow:

	Eastern Points	Akron, O.
	(Per N	Net Ton)
Mixed auto tires S.A.G. auto tires Truck tires Peelings, No. 1 2 3 Tire buffing	Nom. Nom. 40.00 Nom. 16.00	\$13.50/14.00 Nom. Nom. 40.00 Nom. 17.00 Nom.
	(¢	per Lb.)
	(0.0	2.75 5.75 3.75 6.75

Industrial Fabrics

A slightly better tone became evident in some sectors of the industrial fabrics market during the February 15-March 16 period, with trade sources reporting a renewal of inquiry and interest on the part of buyers in various industries after the period had begun sluggishly. Trading was comparatively slow, however, and most transactions involved fill-in lots for spot delivery. The automotive industry did not show interest in covering on wide and other industrial fabrics. A good deal of inquiry was done by such producers as rubber manufacturers and insulators.

Prices of wide industrial fabrics continued to display a soft tone as competition among producers of these fabrics remained sharp for the limited volume of business being transacted. Period-end prices of cotton fabrics were as follows:

INDUSTRIAL FABRICS

59-inch 1.85 yd	
Ducks	
38-inch 1.78-yd. S.F. yd. 2.00-yd. D.F. 51.5-inch, 1.35-yd. S.F. Hose and belting	nom. .30 .4675
Osnaburgs	
40-inch 2.11-yd. yd. 3.65-yd.	.245 .16
Raincoat Fabrics	
Printcloth, 38½-in., 64-60, 5.35-yd. yd. 6.25 yd. Sheeting, 48-inch, 4.17-yd. 52-inch, 3.85-yd.	.135 .1175 .20 .23
Chafer Fabrics	
14.40-oz./sq. yd. Pl yd. 11.65-oz./sq. yd. S	.73 .61 .6575 .67
Other Fabrics	
Headlining, 59-in., 1.65-yd., 2-ply yd. 64-inch, 1.25-yd., 2-ply Sateens, 53-inch, 1.32-yd. 58-inch, 1.21-yd.	.41 .59 .54 .59

Rayon

Total packaged production of rayon and acetate filament yarn during February was 61,300,000 pounds, consisting of 32,000,000 pounds of regular-tenacity yarn and 29,300,000 pounds of high-tenacity rayon yarn. January production had been: total, 69,800,000 pounds; regular-tenacity yarn, 38,200,000 pounds; and high-tenacity rayon yarn, 31,600,000 pounds.

Total filament yarn shipments to domestic consumers came to 57,300,000 pounds in February, of which 27,400,000 pounds were regular-tenacity yarn and 29,900,000 pounds were high-tenacity rayon yarn. Shipments in January had been: total, 71,700,000 pounds; regular-tenacity yarn, 39,300,000 pounds; and high-tenacity rayon yarn, 32,400,000 pounds.

Total end-of-February stocks were 59,-200,000 pounds, made up of 50,600,000 pounds of regular-tenacity yarn and 8,600,000 pounds of high-tenacity rayon yarn. End-of-January stocks had been: total, 58,200,000 pounds; regular-tenacity yarn, 47,000,000 pounds; and high-tenacity rayon yarn, 11,200,000 pounds.

Rayon tire cord and fabric continued to lose ground during 1956. Production was 334,000,000 pounds, representing a 17½% decrease from output during the previous year. Nylon tire cord and fabric picked up by 28%, with 1956 production at 64,000,000 pounds.

Prices of rayon tire yarns and fabrics in mid-March were unchanged from the previous month.

RAYON PRICES

Tire Yarns

\$0.59/\$0.64

High-Tenacity

1100/ 480 1100/ 490

1150/ 490		
1165/ 480		
1230/ 490		
1650/ 720		.55/
1650/ 980		.55/
1875/ 980		
2200/ 960	*****************	.55/
2200/ 980		.55/
2200/1466		.00/
4400/2934	***************	
,		
Super-High	Tenacity	
1650/ 720		
1900/ 720		
	F1 F1 1	
	Tire Fabrics	
100/490/2		
1650/980/2		

Financial

(Continued from page 108)

Garlock Packing Co., Palmyra, N. Y. For 1956: net earnings, \$2,292,308, equal to \$4.64 a share, compared with \$1,622,-609, or \$3.61 a share, in 1955.

General Cable Corp., New York, N. Y., and subsidiary. Twelve months to December 31, 1956: net income, \$12,027,428, equal to \$4.21 a common share, contrasted with \$6,547,558, or \$2.73 a share, in the preceding 12 months; net sales, \$186,645, 106, against \$129,367,506; federal income taxes, \$11,500,000, against \$5,350,000.

Firestone Tire & Rubber Co., Akron, O., and subsidiaries. Quarter ended January 31, 1957: net profit, \$13,710,790, equal to \$1.68 a common share, against \$13,502, 300, or \$1.66 a share, a year earlier; sales, \$268,094,881, against \$264,986,126.

General Electric Co., Schenectady, N. Y. For 1956: net profit, \$213,756,849, equal to \$2.46 a share, against \$208,908,054, or \$2.41 a share, in 1955.

Goodall Rubber Co., Trenton, N. J., and subsidiaries. For 1956: net profit, \$669,289 (a new high), equal to \$1.41 a share, compared with \$543,130, or \$1.27 a share, the year before; net sales, \$12,-004,489 (another record), against \$10,320,-523; federal income taxes, \$634,102, against \$552,926; current assets, \$3,604, 639, current liabilities, \$922,797, against \$3,477,043 and \$1,207,672, respectively, on December 31, 1955.

The B. F. Goodrich Co., Akron. O. For 1956: consolidated net earnings. \$43,765,-431, equal to \$4.90 a common share, compared with \$46,662,127, or \$5.26 a share, the year before; net sales, \$724,168,401, against \$755,016,879; income taxes, \$43,-082,000, against \$48,330,000; current assets, \$343,640,370, current liabilities, \$98,-497,305.

Minnesota Mining & Mfg. Co., St. Paul, Minn., and domestic and Canadian subsidiaries. Year ended December 31, 1956: net income. \$38,723,684, equal to \$2,30 a common share, compared with \$34,699,370, or \$2.07 a share, in the previous year; net sales, \$330,807,692, against \$281,860,717; income taxes, \$37,400,000, against \$35,200,000.

Merck & Co., Inc., Rahway, N. J. For 1956: net income, \$20,224,000, equal to \$1.92 a share, against \$17,147,000, or \$1.55 a share, in 1955.

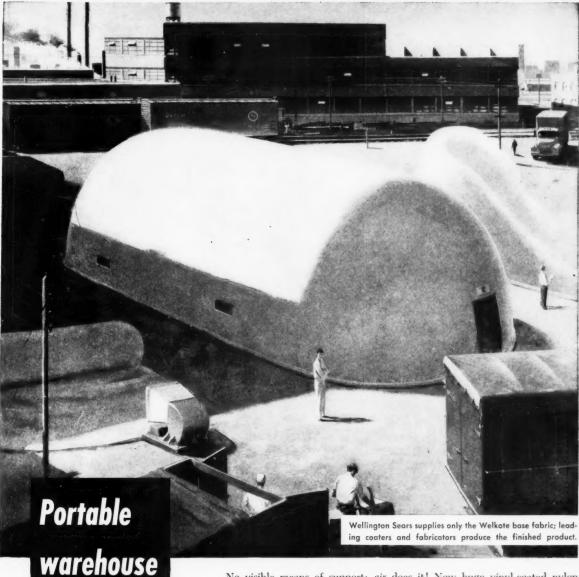
Mount Vernon Mills, Inc., New York, N. Y. For 1956: net income, \$1,471,244, equal to \$2.04 a share, against \$1,250,608, or \$1.90 a share, the year before.

Phillips Petroleum Co., Bartlesville, Okla. For 1956: consolidated net income, \$95,202,615, equal to \$2.77 a share, against \$95,203,057, or \$2.78 a share, in 1955.

Pittsburgh Plate Glass Co., Pittsburgh, Pa. For 1956: net income, \$55,381,729, equal to \$5.62 a share, against \$61,443,716, or \$6.26 a share, in 1955.

Scovill Mfg. Co., Waterbury, Conn. For 1956: net profit, \$4,256,546, equal to \$2.81 a share, compared with \$5,507,892, or \$3.86 a share, in the previous year.

Timken Roller Bearing Co., Canton, O., and subsidiaries. For 1956: net income, \$21,789,664, equal to \$9.00 a capital share, against \$22,100,165, or \$9.13 a share, in 1955; net sales, \$214,475,493, against \$196,054,414; income taxes, \$24,760,000, against \$27,648,000.



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STATISTICS of the RUBBER INDUSTRY

U.S.A. Imports and Production of Natural (Including Latex and Guayule) and Synthetic Rubber (in Long Tons)

Year	Natural	GR-S	SBR-Types	Butyl	Neoprene	N-Type	Total Natural and Synthetic
1951 1952 1953 1954	733,048 805,997 647.615 596,848	694,583 636,969 668,386 472,698	9,946 17,885 12,342 17,707	76,475 81,630 79,801 58,802	58,907 65,745 80,495 69,150	15,333 16,228 20,198 21,396	1,588,292 1,624,454 1,508,837 1,236,601
1955	635,174	236,556	564,589	56,179	91,357	32,623	1,616,478
1956 Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Yrend Adj.	58,803 56,497 52,749 51,394 39,789 36,694 41,195 40,367 42,974 52,638 49,757 57,653 +1,293	••••	76,028 73,457 77,812 74,502 78,309 69,820 70,831 70,122 73,321 70,690 66,482 76,056	6,896 6,229 5,686 5,685 5,647 4,638 7,192 7,118 7,252 7,018 6,065 6,496	8,207 8,560 7,822 8,481 7,795 8,929 7,935 7,769 8,328 8,144 8,614 8,828	3,125 2,989 3,663 3,648 2,903 2,350 2,460 2,141 2,322 2,973 3,092 2,921	153,059 147,732 147,732 143,710 134,443 122,431 129,613 127,517 134,197 141,463 134,010 151,954 +1,293
Total	580,510		877,430	75,922	99,412	34,567	1,667,841
1957							
Jan.*			75,629	6,330	9,432		
and the second							

* Preliminary.

Source: Chemical & Rubber Division, Business & Defense Services Administration, United States Department of Commerce.

U.S.A. Consumption of Natural (Including Latex) and Synthetic Rubber (Long Tons)

Year 1951 1952 1953 1954	Natural 454,015 453,846 553,473 596,285	GR-S 617,200 648,816 611,748 483,001	SBR-Types 9,244 17,604 12,433 17,344	Butyl 70,500 71,229 77,826 61,464	Neoprene 48,887 55,522 65,900 57,203	N-Type 13,066 13,866 16.929 17,715	Total Natural and Synthetic 1,212,912 1,260,883 1,338,309 1,233,412
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Yrend adj.	56,911 50,997 58,472 52,963 54,746 56,282 46,166 48,359 50,963 54,995 52,769 48,377 +2,800	54,728 54,707 62,548 54,091 2,533 3,666 2,690	1,643 1,293 1,189 5,655 60,325 62,226 50,398 59,746 63,330 66,744 68,111 63,149	4,478 4,312 4,839 4,321 4,455 4,704 3,894 4,307 4,578 4,739 4,420 4,219	5,676 5,476 6,423 5,884 6,143 6,320 4,294 6,450 6,197 6,626 6,896 6,491	1,931 1,921 2,174 2,172 1,965 2,581 1,621 2,219 2,270 2,280 2,234 2,167	125,367 118,706 135,645 125,086 130,167 135,779 109,063 121,268 127,338 135,374 134,430 124,403
	-		+3,225	+725		+500	+7,250
Total	634,800	234,963	507,034	53,991	72,876	26,035	1,529,699
1956 Jan. Jan. Apr. Apr. May June July Aug. Sept. Oct. Nov. Dec. Yrend adj.	53,751 50,285 50,040 47,446 48,342 43,638 38,353 46,700 44,179 52,188 42,946 45,220 -1,000		65,375 62,366 64,458 62,179 63,629 56,390 48,907 59,756 57,135 67,399 58,692 60,742 -3,000	4,223 4,155 4,515 4,218 4,228 4,026 3,316 4,102 4,044 4,780 4,093 3,814	6,684 6,430 6,542 6,125 6,379 5,536 4,435 6,554 6,057 7,478 6,676 5,956	2,198 2,289 2,373 2,150 2,103 1,864 1,538 2,125 1,969 2,366 2,065 1,893 +1,000	132,231 125,525 127,928 122,128 124,738 111,454 96,549 119,237 113,384 134,211 114,472 117,625 -3,000
Total 1957	562,088		724,028	49,581	74,852	25,933	1,436,482
Jan.*	52,689		71,926	5,066	7,240	2,307	139,228

* Preliminary.

Source: Chemical & Rubber Division, Business & Defense Services Administration, United States Department of Commerce.



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U.S.A. Stocks of Synthetic Rubber

		(Lor	ng Tons)		
Year	SBR-Types	Butyl	Neoprene	N-Type	Total
1948 1949 1950 1951 1952 1953 1954	96,304 77,743 36,942 105,271 83,861 135,153 115,499 108,989	10,995 12,224 7,243 12,481 22,716 24,866 19,267 10,500	5,072 4,654 5,733 8,379 8,535 11,480 11,349	2,762 3,433 2,840 3,821 3,875 4,346 4,280 6,030	115,133 98,054 52,758 129,952 118,987 175,845 150,395 137,739
1956					
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Yrend. adj.	111,263 114,389 118,063 121,054 127,163 133,570 148,176 154,841 151,646 151,143	12,303 13,027 13,458 14,071 15,253 15,744 18,899 21,267 23,862 25,734 26,998 28,685	11,850 11,888 12,037 12,042 11,478 12,927 15,084 14,540 14,055 12,841 13,459 14,043	6,316 6,602 7,437 8,243 8,788 8,955 9,229 8,503 8,035 7,567 7,734 7,934 +250	141,732 145,906 150,995 155,370 162,682 171,196 188,813 192,486 200,793 197,788 199,334 202,596 +250
	151,934	28,685	14,043	8,184	202,846
1957					
Jan.*	143,593	29,849	13,072	8,438	194,952

Source: Chemical & Rubber Division, Business & Defense Services Administra-tion, United States Department of Commerce.

* Preliminary.

U.S.A. Stocks of Latex

(Long Tons, Dry Weight)

Natural	GR-S*	Neoprene	N-Type	Total Synthetic	Total Natural & Synthetic
11.235					11,235
					5,063
					4,927
	3,727	1.245	532	5,504	10,256
6,201			902	6.961	13,162
13,532	4,794		721	6,632	20,164
11,133	5,134	1,087	811	7,032	18.165
13,203	6,980	1,236	1,807	10,023	23,226
16,059	6,522	1.093	1,906	9,521	25,580
16,735	7,011	1,162		10,116	26,851
18,309	6,867		2,340	10,304	28,613
21,384	7,415	1,163	2,272	10,850	32,234
		1,218	2,194		32,162
	7,447				31,894
19,952				10,406	30,358
					27,280
					24,879
					20,968
					20,602
12,262	7,327	1,4217	ر 2,017	10,765	23,027
		1	200	200	1 200
			+200 >	+200	+200
12,262	7,327	1,421	2,217	10,965	23,227
11,512	7,244	1,275	2,217	10,736	22,248
	11,235 5,063 4,927 4,752 6,201 13,532 11,133 13,203 16,059 16,735 18,309 21,384 21,234 21,033 19,952 18,099 15,403 12,262	11,235 5,063 4,927 4,752 6,201 13,532 1,794 11,133 13,203 16,059 16,059 16,059 16,059 16,059 16,059 16,059 16,867 21,384 7,415 21,234 7,516 21,033 7,447 19,952 18,099 6,402 15,403 16,025 7,228 18,099 6,402 15,403 6,25 12,324 7,327 12,262 7,327	11,235 5,063 4,927 4,752 6,201 5,040 1,019 13,532 4,794 1,117 11,133 5,134 1,087 13,203 6,980 1,236 16,735 7,011 1,162 18,309 6,867 1,097 21,384 7,415 1,163 21,234 7,516 1,218 21,033 7,447 1,328 1,232 1,233 1,421 1,421	11,235 5,063 4,927 4,752 6,201 5,040 1,019 902 13,532 4,794 1,117 721 11,133 5,134 1,087 811 13,203 6,980 1,236 1,807 16,059 6,522 1,093 1,236 1,807 16,735 7,011 1,162 1,943 18,309 6,867 1,097 2,340 21,384 7,415 1,163 2,272 21,234 7,516 1,218 2,194 21,033 7,447 1,328 2,086 19,952 7,288 1,109 2,009 18,099 6,402 1,076 1,703 15,403 16,625 1,328 1,523 12,322 5,703 1,263 1,328 1,523 12,322 5,703 1,263 1,680 11,148 6,282 1,233 1,939 12,262 7,327 1,421 2,017 +200 -2,217	Natural GR-S* Neoprene N-Type Synthetic 11,235

Source: Chemical & Rubber Division, Business & Defense Services Administration, United States Department of Commerce,
* Includes SBR-Types.
† Preliminary.

U.S.A. Imports and Production of Natural

and Synthetic Latices (Long Tons, Dry Weight)

Year 1948 1949 1950 1951 1952 1953 1954	Natural 32,630 29,974 54,401 54,963 48,228 75,511 74,483	GR-S* 21,494 21,357 31,339 32,972 42,273 48,112 48,379	Neoprene 5,022 3,651 5,725 6,866 7,598 9,026 8,214	N-Type 2,948 4,164 5,844 6,866	Total Synthetic 26,516 25,008 37,064 42,786 54,035 62,982 63,459	Total Natural & Synthetic 59,146 54,982 91,465 97,749 102,263 138,493 137,942	
1955		,	0,20	0,000	00,100		
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.	7,853 6,110 7,611 8,550 8,849 7,736 8,702 8,885 8,109 6,900 7,085 6,364	6,199 5,634 7,078 5,680 5,337 4,777 4,800 4,519 5,769 6,231 6,933 6,407	617 797. 854 975 880 905 641 881 994 922 1,004	708 525 738 972 815 1,450 951 1,010 1,091 883 781 874	7,524 6,956 8,670 7,627 7,032 7,132 6,392 6,410 7,854 8,036 8,718 8,243	15,377 13,066 16,281 16,177 15,881 14,868 15,094 15,295 15,963 14,936 15,803 14,607	
Total 1956	92,754	69,364	10,432	10,798	90,594	183,348	
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Yrend adj.	10,328 7,965 7,800 6,995 5,731 5,006 3,522 4,715 2,790 5,738 4,761 6.661	6,885 6,943 5,911 6,997 4,766 4,241 4,902 5,723 6,122 6,053 7,143	848 930 782 969 939 907. 444 882 1,180 908 886 967	919 827 1,158 866 614 543 731 684 938 1,183 1,175 1,012	8,652 8,700 7,851 7,922 6,519 6,226 5,416 6,468 7,841 8,213 8,114 9,122	18,980 16,665 15,651 14,917 12,250 11,232 8,938 11,183 10,631 12,875 15,783	
Total	71,718	69.762	10,642	10,650	91,054	162,772	
1957							
Jan.*			905	960			

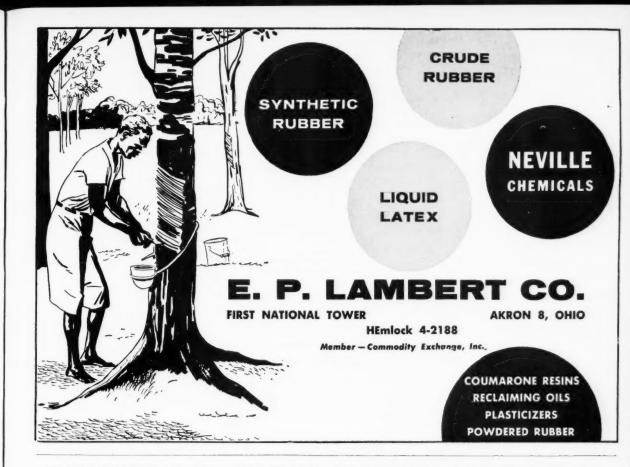
Source: Chemical & Rubber Division, Business & Defense Services Administra-tion, United States Department of Commerce. † Includes SBR-Types. † Preliminary.

U.S.A. New Supply, Consumption, Exports, and Stock of Reclaimed Rubber

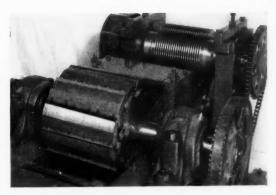
		(Long Tons)		
Year 1948 1949 1950 1951 1952 1953 1954	New Supply 266,861 224,029 314,008 366,700 274,981 298,336 258,101	Consumption 261,113 222,679 303,733 346,121 280,002 285,050 249,049	Exports 11,428 10,367 11,740 14,722 11,180 11,397 10,232	Stocks 32,630 28,263 35,708 45,082 30,664 32,319 30,746
1955 Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Yearend adj	25,336 25,444 29,574 26,817 27,911 30,451 24,114 25,223 26,512 28,038 29,124 28,105	25,322 24,333 28,674 26,609 27,652 29,157 22,563 25,790 26,340 26,597 27,229 24,515 -2,000	1,041 1,085 1,088 1,088 1,056 1,128 1,176 1,144 1,018 1,381 1,313 1,470	29,656 30,125 30,311 30,068 29,528 29,725 29,939 27,956 27,110 27,565 28,473 31,058 +440
Total	326,649	312,781	13,988	31,498
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Year-end. adj.	26,205 27,108 28,468 26,933 25,485 22,153 19,776 21,724 22,368 26,318 20,009 20,673	25,827 25,571 26,176 23,999 23,560 20,560 18,099 21,498 20,242 23,946 20,832 20,737 —500	1,382 1,115 1,163 1,179 1,297 1,264 952 1,076 1,015 1,298 1,189 902	31,640 31,875 33,326 34,360 34,863 35,647 35,703 35,512 36,527 37,904 36,063 34,969
Total 1957	287,220	270,547	13,832	34,969
Jan.*	25,001	24,081		34,598

Source: Chemical & Rubber Division, Business & Defense Services Administration, United States Department of Commerce.

* Prliminary.



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U.S.A. Exports of Synthetic Rubber

		(Lo	ng Tons)		
Year 1954 1955	SBR-Types 11,069	Butyl 2,831	Neoprene 12,062	N-Type 4,155	Total 30,117
Jan.	1,381	716	1,046	194	3,337
Feb.	1,331	370	1,049	259	3,009
Mar.	2,162	672	1,287	236	4,357
Apr.	1,807	1,562	1,636	506	5,511
May	3,500	376	1,430	357	5,663
June	6,030	726	1,541	389	8,686
July	5,212	870	1,275	472	7,829
Aug.	7,727	837	1,454	386	9,567
Sept.	8,598	526	1,946	602	11,672
Oct.	7,888	1,041	1,748	444	11,121
Nov.	7,786	894	1,824	306	10,810
Dec.	7,282	1,305	1,862	442	10,891
Total	60,704	9,895	18,098	4,593	93,290
1956					
Jan.	7,550	815	1,757	506	10,628
Feb.	9,018	1,624	1,521	449	12,612
Mar.	10,804	764	1,500	522	13,590
Apr.	10,271	374	1,917	587	13,149
May	10,864	743	2,142	443	14,192
June	9,558	746	2,088	548	12,940
July	9,038	523	1,994	433	11,988
Aug.	9,607	654	2,268	274	12,803
Sept.	8,804	439	2,824	403	12,470
Oct.	6,795	454	1,013	618	8,880
Nov.	4.789	247	1,056	551	6,643
Dec.	15,268	1,316	1,829	860	19,273
Total	112,366	8,699	21,909	6,194	149,168

Source: Chemical & Rubber Division, Business & Defense Services Administra-tion, United States Department of Commerce.

U.S.A. Synthetic Rubber Exports, by Country (Including Latices)

	January-No	ovember,	1956 (Long	Tons)	
Country	SBR-Types	Butyl	Neoprene	N-Type	Total
U.K.	15,499	260	3,521	646	19,926
Belgium	3,264	378	4.393	147	8,182
France	12,035	1.736	1,366	591	15,728
Germany	10,047	2,037	1.910	735	14,729
Italy	5,327	340	1,336	541	7,544
Sweden	2,755	150	132	306	3,343
Argentina	2,760	266	235	58	3,319
Australia	8,104	177	335	85	8,701
Canada	6,108	20	3,061	277	9,466
Japan	2,937	381	1,797	1,016	6,131
Mexico	6,554	589	164	83	7,390
South Africa	6,786	542	444	35	7,807
Venezuela	2,379	79	43	1	2,502
All others	12,543	427	1,344	814	15,128
Total	97,098	7,382	20,081	5,335	120,896

Source: Secretariat of the International Rubber Study Group.

U.S.A. Automotive Inner Tubes

(Thousands	of	Units)
Shipments		

		Ship		T		
Year 1954 1955	Original Equip- ment 25,090 5,002	Re- place- ment 35,442 33,360	Export 948 999	Total 61,480 39,363	Produc- tion 58,397 35,900	Inventory End of Period 9,299 6,833
1956						0,000
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.	274 273 282 265 280 269 248 242 213 261 259 235	3,263 2,548 2,587 2,444 2,515 3,023 3,055 2,954 2,472 2,514 2,468 2,515	72 100 93 88 83 79 82 99 91 102 65 87	3,608 2,921 2,962 2,878 3,370 3,384 3,295 2,777 2,877 2,877 2,878 2,838	2,918 2,969 3,347 3,094 3,093 2,837 2,300 2,795 2,774 3,025 2,585 2,670	6,294 6,547 6,848 7,312 7,657 7,349 6,418 5,962 6,056 6,469 6,250 6,109
Total	3,101	32,358	1,041	36,499	34,407	
1957						
Jan.	274	3,263	72	3,608	2,918	6,294

Source: The Rubber Manufacturers Association, Inc.

U.S.A. Consumption of Natural and Synthetic Latices

		(Lo	ng Tons, Dry	Weight)		
Year	Natural	GR-S*	Neoprene	N-Type	Total Synthetic	Total Natural & Synthetic
1954 1955 1956	75,931 86,478	44,173 63,982	7,251 8,736	4,507 8,495	55,931 81,213	131,862 167,691
Jan. Feb. Mar. Apr. May June July Aug.	6,776 6,399 6,438 5,693 5,239 5,171 4,855 6,374	5,858 5,913 5,888 4,923 4,745 4,350 3,731 5,055	772 787 729 741 778 637 562 816	670 730 781 692 691 657 466 698	7,300 7,430 7,398 6,356 6,214 5,644 4,759 6,569	14,076 13,829 13,836 12,049 11,453 10,815 9,614 12,943
Sept. Oct. Nov.	6,233 7,825 6,431	4,937 6,175 5,406	692 795 723	699 681 659	6,328 7,651 6,788	12,561 15,476 13,219
Dec. Yrend adj.	6,666 -1,000	5,399 +3,000	701	710 +800	6,810 +3,800	13,476 $+2,800$
Total	73,100	65,380	8,733	8,934	83,047	156,147

812 Source: Chemical & Rubber Division, Business & Defense Services Administra-tion, United States Department of Commerce. † Preliminary. * Includes SBR-Types.

Jan.*

7,038

6,788

U.S.A. Rubber Industry Sales and Inventories

(Million of Dollars)

722 8,322

	(Willion of Bollars)							
	Value of Sales*				Man	ufacture	rs' Inver	tories*
	1953	1954	1955	1956	1953	1954	1955	1956
Jan.	424	348	424	415	866	844	790	935
Feb.	435	351	440	445	868	857	782	970
Mar.	473	388	466	451	880	849	805	979
Apr.	444	375	445	445	874	812	784	970
May	422	357	465	464	888	810	810	985
June	436	377	465	450	914	829	850	975
July	448	374	471	459	925	784	853	987
Aug.	409	337	456	436	897	761	863	1,007
Sept.	416	334	456	429	908	804	874	1,007
Oct.	395	332	447	454	881	838	902	1,022
Nov.	346	388	482	463	867	819	935	1,024
Dec.	369	407	465		868	929	934	
Total	5,017	4,368	5,493		v. 853	831	845	

Source: Office of Business Economics, U. S. Department of Commerce. * Adjusted for seasonal variation,

U.S.A. Synthetic Rubber Industry, Wages, Hours

Year	Average Weekly Earnings	Average Weekly Hours	Average Hourly Earnings
1954	\$90.76	40.7	\$2.23
1955			
Jan.	93.02	40.8	2.28
Feb.	93.07	41.0	2.27
Mar.	94.12	41.1	2.29
Apr.	99.5	42.9	2.32
May	95.22	41.4	2.30
June	96.51	41.6	2.32
July	97.53	41.5	2.35
Aug.	99.96	42.0	2.38
Sept.	100.08	41.7	2.40
Oct.	98.83	41.7	2.37
Nov.	100.14	41.9	2.39
Dec.	100.98	41.9	2.41
1956			
Jan.	101.88	42.1	2.42
Feb.	101.57	41.8	2.43
Mar.	102.51	41.5	2.47
Apr.	102.75	41.6	2.47
May	103,00	41.2	2.50
June	103.41	41.2	2.51
July	103.41	41.5	2.50
Aug.	108.03	42.2	2.56
Sept.	104.90	41.3	2.56 2.54
Oct.	107.52	42.0	2.56
Nov.	103.57	41.1	2.52

Source: BLS, United States Department of Labor.

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Medium-size Philadelphia area plant needs a man as assistant to the chief chemist. Must have degree and a minimum of two years' factory experience in compounding. Excellent potential—salary commensurate with ability. Send résumé to Box No. 2053, care of Rubber World.

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Two to five years' experience in rubber, resins or plastics. BISHOP MANUFACTURING CORPORATION, Cedar Grove, N. J.

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THE NAME TO REMEMBER FOR PRECISION

Manufacturers of the World's Finest Rubber Curing Equipment

World Production of Natural Rubber

(1,000 Long Tons)

	Ma	laya	Ind	onesia		
Year	Estate	Native	Estate	Native	All Other	Total
1955 Jan. Feb. Mar Apr. May June July Aug. Sept. Oct.	29.3 28.5 27.5 24.2 27.4 27.6 30.3 30.7 31.3 30.8	27.9 20.4 26.7 20.5 22.4 22.9 25.7 23.6 24.9 24.0	23.6 22.3 23.0 20.7 18.0 21.3 21.2 20.0 20.3 22.0 23.4	17.1 48.1 23.8 27.4 30.1 52.7 32.5 43.2 45.2 44.8 37.3	42.1 38.2 39.0 42.2 37.1 40.5 55.3 37.5 45.8 48.4 44.6	140.0 157.5 140.0 135.0 135.0 165.0 165.0 167.5 170.0
Nov. Dec.	30.3 35.0	21.9 27.3	23.4	70.2	50.5	207.5
Total	352.9	286.2	261.3	472.4	521.2	1,895.0
1956 Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.	32.6 27.6 28.5 26.7 23.5 29.5 30.8 30.2 30.5 28.4 34.7	26.5 24.3 22.5 21.7 19.8 23.2 23.9 23.0 21.9 22.5 21.3 24.2	23.5 23.0 21.5 20.0 18.0 21.9 21.3 20.3 21.3 22.0 21.9 23.0	17.4 20.9 16.4 46.1 38.4 25.9 41.5 64.0 29.0 34.0 44.4 49.5	42.5 36.7 41.1 40.4 37.8 44.5 45.0 44.9 42.6 53.5 51.5 53.6	142.5 132.5 130.0 155.0 137.5 145.0 162.5 182.5 145.0 162.5 167.5
Total	353.0	274.4	258.2	428.5	558.4	1,872.5
1957 Jan.	36.1	27.3				

Source: BDSA, United States Department of Commerce; Secretariat of the International Rubber Study Group; and United Baltic Corp., Ltd.

World Production of Synthetic Rubber

	(1,0	00 Long Tons)	
Year	U.S.A.	Canada	Germany	Total
1955 Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.	69.9 67.7 78.5 75.7 82.0 78.2 81.9 84.0 83.5 89.1 91.3	8.1 7.6 8.7 7.6 8.9 8.6 8.2 8.1 9.3 9.9 9.7	0.9 0.8 0.8 0.9 0.9 1.0 0.9 1.0	78.9 76.2 88.0 84.1 91.7 87.7 91.0 93.1 93.7 100.0 101.5
Total	970.5	103.9	10.9	1,085.3
1956 Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.	93.5 90.5 94.4 91.6 93.7 85.3 88.0 86.5 90.6 88.2 83.5 93.8	9.7 8.2 10.3 10.3 10.6 10.4 8.7 10.2 10.7 10.7 10.3 10.6	1.0 1.0 1.1 1.0 1.0 0.6 1.0 0.9 0.8 0.8	104.3 99.7 105.8 102.8 105.3 96.3 97.7 97.6 102.1 99.7
Total	1,079.6	120.7	11.1	

Source: Secretariat of the International Rubber Study Group; and BDSA, United States Department of Commerce.

U.S. Replacement Auto Tire Sales

(Thousands of Units)

	D 6	Replacement		
Year	Passenger Car Registrations	Auto Tire Sales	Tire Sales Per Car	New Car Registrations
1954	48,323	47,045	.97	5,535
1955	51,989	50,189	.96	7.170
1956*	54,300	53,400	.98	5,955
1957†	56,400	55,300	.98	6,100

* Preliminary. † Estimated. Source: Natural Rubber Bureau.

World Consumption of Natural Rubber

(1,000 Long Tons)

		1.0	,000 2025	,		
Year	United States	U.S.S.R.* and China		Other Foreign	Total Foreign	Grand* Total
1955						
Jan.	56.9	7.8	23.5	71.8	103.1	160.0
Feb.	51.0		20.1	72.0	89.0	140.0
Mar.	58.5	7.3	21.4	72.8	101.5	160.0
Apr.	53.0		23.3		104.5	157.5
May	54.7		20.5		97.8	152.5
June	56.3	2.8	18.3	80.1	101.2	157.5
July	46.2	1.8	18.3	73.7	93.8	140.0
Aug.	48.4	0.1	16.0	65.5	81.6	130.0
Sept.	51.0	2.1	19.8	72.1	94.0	145.0
Oct.	55.0	10.4	22.9	76.7	110.0	165.0
Nov.	52.8	17.1	20.0	77.6	114.7	167.5
Dec.	51.2	5.2	22.2	83.9	111.3	162.5
Total	634.8	56.2	246.3	900.2	1,202.7	1,837.5
1956						
Jan.	53.4	14.4	21.7	73.0	109.1	162.5
Feb.	50.1	19.1	17.9	72.9	109.9	160.0
Mar.	49.6	11.7	16.0	73.7	100.4	150.0
Apr.	47.0	14.6	18.4	72.5	105.5	152.5
May	48.3	16.8	14.5	75.4	106.7	155.0
June	43.6	20.8	16.1	82.0	118.9	162.5
July	38.4	16.6	14.7	75.3	106.6	145.0
Aug.	46.7	7.1	10.3	73.4	90.8	137.5
Sept.	44.2	17.1	14.5	81.7	113.3	157.5
Oct.	52.2	15.5	18.8	76.0	110.3	162.5
Nov.	43.0	27.2	15.7	76.6	119.5	162.5
Dec.	45.2	29.9	14.3	73.1	117.3	162.5
Total	563.1	215.0	192.8	914.1	1,321.9	1,885.0

Source: BDSA, United States Department of Commerce; Secretariat of the International Rubber Study Group; and United Baltic Corp., Ltd.
* Estimated.

World Consumption of Synthetic Rubber*

(1,000 Long Tons)

World+
Grand Total
80.0
77.5
90.0
85.0
87.5
92.5
75.0
92.5 75.0 87.5 92.5
92.5
97.5
97.5
95.0
1,057.5
100.0
95.0
97.5
97.5
97.5
90.0
80.0
90.0
90.0
105.0
95.0
97.5
1,135.0

Source: Secretariat of the International Rubber Study Group; BDSA, United States Department of Commerce.

* Includes latices. † Figures estimated or partly estimated.

UK Rubber Use By Main Products, 1956

Natural

	Latex	Total	Synthetic	Grand Total
Tires and tubes	548	97,995	28.158	126,153
Belting	24	5,243	768	6,011
Cables		7.868	1,576	9,444
Footwear	1,061	22,289	2,035	24,324
Hose	161	3,222	1,037	4,259
Cellular rubber	13,529	15,327	51	15,378
Other	8,282	40.876	5,900	46,776
Total	23 605	192 820	30 525	232 345

Source: Secretariat of the International Rubber Study Group.

MACHINERY & SUPPLIES FOR SALE (Continued)

FOR SALE: STAINLESS-STEEL DOUBLE-ARM SIGMA BLADE Jacketed Mixers: J. H. Day 5, 50, and 75 gal. Kux model 25 rotary pellet presses, 21 and 25 punch. (7) Vacuum Shelf Dryers, 55, 80, 475 sq. it. Marco Process, all stainless-steel consisting of: KACR Reactor, Kom-Binators, Hormogenizer, Roto-Feed Mixers, Proportioners, etc. PERRY EQUIPMENT CORP., 1424 N. 6th St., Phila. 22, Pa.

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HARTIG 34" ENTRUDER & OTHER SIZES. STOKES & KUX 2½"-dia. single-punch Preform Machines. Rubber Mills from Lab. size to 84". New & used Lab. 6" x 13", 6" x 16" and 8" x 16" Mills and Calenders. Baker-Perkins & Day heavy-duty jack. Mixers up to 150 gals. 800-ton Hydraulic Press multi-opening. 26" x 38" platens. 300-ton multi-opening 40" x 40" platens. 200-ton 20" x 80" platens. 140-ton 36" x 36" platens. 120-ton semi-automatic 18" x 22" olatens. Stokes 15-ton fully autom. Molding Press. 150-ton 24" x 24" platens. 80-ton 18" x 18" platens. Large stock Hydr. Presses 12" x 12" to 48" x 48" platens. Hydraulic Pumps & Accumulators. Rotary Cutters. Stokes Molding Presses. Single Punch & Rotary Preform Machines. Banbury Mixers, Crushers, Churus, Bale Cutters, Gas Boilers, etc. SEND FOR SPECIAL BULLETIN. WE BUY YOUR SURPLUS MACHINERY. STEIN EQUIPMENT CO., 107—8th Street, Brooklyn, N. Y. STEFIN 8-1944.

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"ARMACO"

U.S.A. Automotive Pneumatic Casings (Thousands of Units)

U.S.A. Rubber Industry Employment, Wages, Hours

		Shipr	nents	Omis)				Dandustian	wages,		A.u	Consum
1	Priginal Equip- ment	Re- place- ment	Export	Total	Produc- tion	Inven- tory End of Period	Year	Production Workers (1000's)	Average Weekly Earnings	Average Weekly Hours	Average Hourly Earnings	Consum- ers Price Index
Passenger C		********	Laport	20141	12011	1 01100			All Rubber			
1954 2 1955	29, 746 42,574	47,043 50,156	928 966	77,717 93,698	76,806 97,232	12,228 15,963	1939 1954 1955	121 195	\$27.84 78.21	39.9 39.7	\$0.75 1.97	114.8
Jan.	2,958	4,040	66	7,064	7,661	16,546	Aug.	219.0 223.1 226.4	86.32 86.74 89.04	41.3 41.5	2.09 2.09 2.12	114.5 114.9
Feb Mar	2,919 3,027	3,387 4,372	90 65	6,396 7,464	7,571 7,812	16,546 17,701 18,096	Sept. Oct.	226.4	89.04	42.0	2.12	114.9
Apr	2,787	4,994	67	7.847	7,530	17,649	Nov.	231.2	92.01	42.4	2.17 2.16	115.0
May June	2,787 2,349 2,162	5,203 5,659	65 64	7,617 7,885	7 628	17,714	Dec. 1956	233.9	89.21	41.3	2.10	114.7
July	2,471 1,953	5,482	73 77	8,026	6,600 5,669 6,897	14,088	Jan.	232.5	87.91	40.7	2.16	114.6
Aug Sept	1,953 1,262	5,359 4,427	77 70	7,389	6,897 6,647	13,578	Feb. Mar.	227.6 224.7	85.81 84.93	40.1 39.5	2.14	114.6 114.7
	2,530	3.854	87	8,026 7,389 5,758 6,471	7,526 6,580	15,607	Apr.	224.6 215.9	85.79	39.9	2.15	114.9
Nov.	3,179 3,277	3,255 3,220	62 90	6,496 6,587	6,580 7,425	17,649 17,714 16,443 14,088 13,578 14,468 15,607 15,596 16,494	May June	211.3	86.18 84.93	39.9 39.5	2.16	115.4 116.2
2000						10,474	July	207.3 209.3	86.15 87.64 89.51	39.7	2.14 2.15 2.15 2.16 2.17 2.18 2.21 2.21	117.0 116.8
Total 3	30,874	42,411	876	85,000	95,546		Aug. Sept.	216.6	89.51	40.2 40.5	2.10	117.1
Jan	3,192	4,521	100	7,812	8,296	16,978	Oct.	217.7	90.17 88.70	40.8	2.21 2.19	117.1 117.7 117.8
ruck and B	Bus						Nov. Dec.	206.0 217.9	88.70	40.5	2.19	118.0
954 955	3,592	8,111	826	12,529	12,347	2,546			Tires and			
Jan	303	827	81	1,211	1,243	2,586	1939	54.2	\$33.36	35.0	\$0.96	
Feb Mar	294 454	730 672	74 96	1,098	1,243 1,196 1,273 1,153 1,208 1,320 1,134 1,132 1,243 1,395	2,678 2,734 2,693	1954	54.2 79.7	87.85	38.7	2.27	
Apr May	489	639	76	1,222 1,204	1,153	2,693	1955 Aug.	91.0	102.72	42.1	2.44	
June	481 449	655 730	65 76	1,202 1,255 1,389 1,359	1,208 1,320	2,701	Sept.	91.9	101.02	41.4	2.44	
July	429	909	51	1,389	1,134	2,485	Oct. Nov.	92.3 94.2	103.74 106.26	42.0 42.0	2.47 2.53	
Aug. Sept.	378 393	922 804	59 66	1,359	1,132	2,701 2,763 2,485 2,272 2,268 2,357 2,584 2,815	Dec.	94.7	99.50	39.8	2.50	
Oct.	324	904	88	1,264 1,315 1,180	1,395	2,357	1956	04.1	101.00	40.4	2.50	
Nov Dec	403 404	690 552	87 91	1,180	1,405 1,255	2,584	Jan. Feb.	94.1 93.7	101.00 97.71 97.89	39.4	2.50 2.48	
_	4.001					2,010	Mar.	93.3 91.8	97.89 98.00	39.0 39.2	2.51 2.50	
Total 956	4,801	9,034	910	14,746	14,957		Apr. May	91.6	99.00	39.8	2.51	
Jan.	444	629	65	1,139	1,318	2,971	June July	90.1 90.8	99.00 98.25 98.14	39.3 39.1	2.50 2.51	
Feb. Mar.	424	565 662	88 62	1,077	1,326	2,971 3,232 3,465	Aug.	89.8	101.20	40.0	2.53	
Apr.	430	767	74 65	1,163 1,271 1,264	1,303	3,483 3,582	Sept. Oct.	91.6 91.7	101.20 102.51 102.66	40.2 40.1	2.55 2.56	
May June	421 372	777 968	65 65	1,264 1,404	1,358	3,582 3,504	Nov.	80.3	104.45	40.8	2.56	
July	362	837	73	1,272 1,254	1,318 1,326 1,382 1,303 1,358 1,329 1,073 1,154 1,153 1,273	3,504 3,306 3,217 3,180			Rubber Fe	notwear		
Aug Sept	349 291	820 811	86 92	1.194	1,154	3,217	1939	14.8	\$22.80	37.5	\$0.61	
Oct.	378	849	92 78	1,305	1,273	3.168	1954	20.7	67.43	39.9	1.69	
Nov Dec	337 301	626 583	59 76	1,022 961	1,060 1,130	3,207 3,378	1955 Aug.	21.5	67.25	39.1	1.72	
Total	1 5 1 8	8,894	883	14,326	14,589		Sept.	21.5 23.5	67.60	39.3	1.72	
957	4,,,40	0,074	003	14,320	14,209		Oct. Nov.	24.4 25.5	69.20 77.89	40.0 42.1	1.73 1.85	
Jan.	305	678	83	1,066	1,208	3,512	Dec.	26.2	74.89	40.7	1.84	
otal Autom							1956 Jan.	26.2	74 37	40.2	1.85	
54 3 55	3,338	55,154	1,754	90,246	89,153	14,774	Feb.	26.2 26.1 25.8	74.37 74.74 71.16 72.25 72.25	40.4	1.85	
Jan.	3.785	4,967	159	8,911	9,040	14,949	Mar. Apr.	25.8	71.16	39.1 39.7	1.82 1.82 1.82	
Feb Mar	4.780	4,281 4,926	157 201	8,272 9,907	8,745 10,083	15,321 15,609	May	20.0	72.25	39.7	1.82	
Apr May	4,457 4,352	5,315	165	9,937 9,865 10,234 9,729	9,153 9,949 10,703	14.890	June July	19.4 18.9	70.53 71.28	39.4 39.6	1.79 1.80	
June	3,931	5,361 6,129	152 174	10,234	10,703	14,936 15,460	Aug.	19.2	70.35 71.71	39.3 39.4	1.79 1.82	
July	3,890	5.711	128 119	9,729	9.027	14,684	Sept. Oct.	19.3 19.1	71.71	39.4	1.82	
Sept	3,362 3,142	5,980 5,171	140	8,453	9.027 8,717 9,125	13,908 14,675	Nov.	18.6	71.55	39.1	1.83	
Oct Nov	3,495	4.460 3,592	161	8,117 8,045	9,555 9,603	16,163 17,727			Other Rubbe	r Products		
Dec.		3,298	172	7,515	8,478	11,121	1939	51.9	\$23.34	38.9	\$0.61	
Total 4	17.375	59,191	1,878	108,447	112,178		1954 1955	94.3	71.91	40.4	1.78	
956	,,,,,,,	,	1,070	100,447	112,170		Aug.	104.3	75.85	41.0	1.85	
Jan. Feb	3,402	4,669 3,953	131 178	8,203 7,473	8,979 8,897	19,517 20,934	Sept. Oct.	107.7 109.7	78.96 80.56	42.0 42.4	1.88 1.90	
Mar	3 466	5,034	127	8,627	9,193	21,562	Nov.	111.5	83.03	42.8	1.94	
Apr May	3,217	5,761 5,980	141 130	9 1 1 9	8,834 8,987	21,562 21,132 21,296	Dec.	113.0	83.69	42.7	1.96	
June	3,217 2,770 2,533 2,833 2,303	6,627	129	8,880 9,289 9,298	7,930	19,947 17,394	1956 Jan.	112.2	79.73	41.1	1.94	
July	2,833	6,319 6,179	146 163	9,298 8,644	6,741 8,050	17,394 16,795	Feb.	107.8	77.95	40.6	1.92	
Sept	1,333	5,238 4,703	162	6,952	7,800	17.648	Mar. Apr.	105.6 106.6	76.99 77.95	40.1 40.6	1.92 1.92	
Oct.	2,908 3,516	4,703 3,881	165 121	7,776 7,518	8,799 7,641	18,775 18,803	May	104.7	76.40	40.0	1.91 1.91	
Dec.	3,579	3,803	166	7,548	8,556	19,872	June July	99.0 99.1	76.02 77.78	39.8 40.3	1.93	
Total 3	5 473	62,147	1,759	99,327	100,407		Aug.	101.8	78.76	40.6	1.94	
	CaTaJ	Um, 147	1,727	77.321	100,407		Sept. Oct.	195.2 109.2	81.18 82.98	41.0 41.7	1.98	
957								107.1	79.98	40.6	1.97	

Source: The Rubber Manufacturers Association, Inc.

Source: BLS, United States Department of Labor.

MACHINERY & SUPPLIES FOR SALE (Continued)

ONE SOUTHWARK-BALDWIN SLAB-TYPE PRESS. 10 OPENings. $2\frac{1}{2}$ inches Daylight. 11 Steamheated Platens, $32\times32\times2^{\prime\prime}$ thick. Chrome-plated ram $24^{\prime\prime}$ diameter, Stroke: $24^{\prime\prime}$. In good condition. THE DANBURY RUBBER CO., INC., Danbury, Connecticut.

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Production of Cotton, Rayon, and Nylon Tire Fabrics

	Cotton					Rayon			
1954	Tire Cord Not Woven	Tire Cord Fabric Woven	Chafer and All Other Tire Fabrics	Total	Tire Cord Not Woven	Tire Cord and Other Tire Fabrics	Total	Nylon Tire Cord and Fabrics	Total* Synthetic Tire Cord and Fabrics
JanMar. AprJune July-Sept. OctDec.	‡ ‡ ‡	2,585 4,067 2,104 3,743	13,229 12,830 9,321 12,476	15,814 16,897 11,425 16,219	17,297 12,436 12,851 14,609	73,068 66,796 50,136 76,931	90,365 79,232 62,987 91,540	5,320 8,357 6,754 9,338	95,685 87,589 69,741 100,878

	Cotton	and Nylona	Rayon T	ire Cord	
1955 JanMar. AprJune July-Sept. OctDec. Total	Cotton Chafer Fabrics and Other Tire Fabrics 12,763 12,728 12,941 12,333 50,765	Cotton and Nylon Tire Cord and Fabrics 14,870 18,527 16,093 15,754 65,244	Woven 79,191 80,908 81,996 77,600 319,695	Not Woven 20,299 21,550 20,740 24,343 86,932	Total All Tire Cord and Fabrics 127,123 133,713 131,770 130,030 522,636
1956 JanMar. AprJune July-Sept. OctDec. Total	12,815 10,322 7,958 9,497 40,592	16,483 19,471 18,958 19,720 74,632	74,833 61,196 56,961 55,639 248,629	23,707 21,557 18,698 20,071 84,033	127,838 112,546 102,575 104,927 447,886

Carbon Black Statistics-1956

Furnace blacks are classified as follows: SRF, Semi-reinforcing furnace black; HMF, high modulus furnace black; FEF, fast-extruding furnace black; HAF, high abrasion furnace black; SAF, semi-abrasion furnace black.

(Thousands of Pounds)

Thermal 11, SRF 34, HMF 10,	401 8,681 776 19,518 802 36,807	Mar 12,127 31,692 7,984 21,359 38,058 16,228	Apr. 10,665 28,711 8,764 19,948 33,832 20,145	May 11,712 31,622 8,972 18,339 38,830 17,149	June 11,483 29,081 8,066 20,118 37,542 16,172	July 11,577 30,860 7,479 17,890 38,334 14,250	Aug. 12,413 29,504 8,437 15,270 35,679 16,458	Sept. 11,927 29,107 8,394 14,995 31,211 21,526	Oct. 13,534 30,005 8,628 16,321 40,764 20,296	Nov. 12,994 27,072 10,611 15,883 39,571 16,762	Dec. 13,467 27,402 10,228 16,202 39,408 15,480	Total 145,251 359,470 106,645 216,619 446,838 201,939
Total furnace 127, Contact types 32,	818 120,406 222 28,717	127,448 31,552	122,065 30,460	126,624 30,613	122,462 29,011	120,390 30,120	117,761 29,782	117,160 30,144	129,548 30,972	122,893 29,621	122,187 30,459	1,476,762 363,673
Γotals 160,0	040 149,123	159,000	152,525	157,237	151,473	150,510	147,543	147,304	160,520	152,514	152,646	1,840,435
Shipments Furnace types Thermal 11, SRF 32, HMF 9, FEF 19, HAF 36, SAF, ISAF 14,	165 26,973 453 8,420 381 16,379 934 35,142	11,204 27,492 9,051 17,559 36,374 15,637	10,242 25,239 9,184 18,369 31,287 15,015	10,376 26,646 8,068 17,413 37,319 14,517	8,327 19,893 8,483 15,054 32,698 13,055	8,326 20,242 7,519 14,311 33,799 13,610	10,917 22,109 8,195 16,340 34,502 13,962	12,580 25,682 8,987 18,576 35,328 15,366	13,347 33,329 11,821 20,770 43,819 16,483	12,554 19,103 8,328 14,784 29,052 11,242	11,379 23,728 9,924 17,928 40,761 14,671	132,459 302,601 107,433 206,864 427,015 172,820
Total furnace 124,2 Contact types 33,2	279 113,037 256 31,548	117,317 30,377	109,336 31,032	114,339 31,582	97,510 29,609	97,807 28,661	106,025 32,500	116,519 35,352	139,569 36,807	95,063 25,444	118,391 36,323	1,349,192 382,491
Γotals 157,5	35 144,585	147,694	140,368	145,921	127,119	126,468	138,525	151,871	176,376	120,507	154,714	1,731,683
Producers' Stocks, End of Furnace types 6,0 Thermal 6,0 SRF 21,0 HMF 21,3 FEF 24,9 HAF 36,3 SAF, ISAF 26,6	13 6,130 21 24,415 04 21,565 57 28,096 23 37,988	7,053 28,615 20,498 31,896 39,672 26,053	7,476 32,087 20,078 33,475 42,217 31,133	8,812 37,063 20,982 34,401 43,728 33,815	11,968 46,251 20,565 39,465 48,572 36,932	15,219 56,869 20,525 43,044 53,107 37,572	16,715 64,264 20,767 41,974 54,284 40,068	16,062 67,689 20,174 38,393 50,167 46,228	16,249 64,365 16,981 33,944 47,112 50,041	16,689 72,334 19,264 35,043 57,631 55,561	18,777 76,008 19,568 33,317 56,278 56,370	18,777 76,008 19,568 33,317 56,278 56,370
Total furnace 136,2 Contact types 95,2	87 143,656 94 92,463	153,787 93,638	166,516 93,066	178,801 92,097	203,753 91,499	226,336 92,958	238,072 90,240	238,713 85,032	228,692 79,197	256,522 83,374	260,318 77,510	260,318 77,510
Totals	81 236,119	247,425	259,582	270,898	295,252	319,294	328,312	323,745	307,889	339,896	337,828	337,828
Exports Furnace types 21,8 Contact types 11,8		24,105 12,607	17,295 14,957	19,647 12,189	22,922 14,662	17,545 12,767	18,630 16,773	21,529 16,491	25,295 18,930	12,516 8,928	24,309 19,717	250,324 175,004
Γotals	92 39,822	36,712	32,252	31,836	37,584	30,312	35,403	38,020	44,225	21,444	44,026	425,328

Source: Bureau of Mines, United States Department of the Interior, Washington, D. C.

^{*} Fuel cell fabrics not included with rayon and nylon tire cord and fabrics,

‡ Included with "Tire Cord Fabric Woven" to avoid disclosing data for individual mills.

a Cotton and nylon figures combined to avoid disclosing data for individual companies.

Source: Bureau of the Census, United States Department of Commerce.

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